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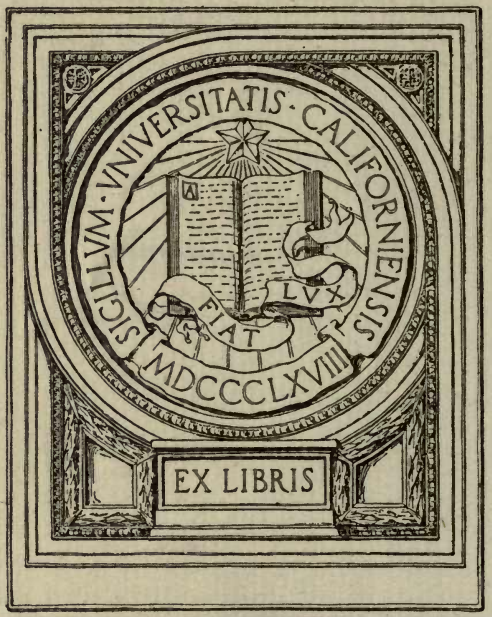
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PART VI.

MINERALOGY AND GEOLOGY.

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MINERALOGY AND GEOLOGY.

I.—Crystallography.

Models of Crystals.

A.—*Wire Models.*

1. Wire models of the five regular solids.
1860. *Exhibited by J. R. Larkin.*

Six inches in diameter. They comprise (1) the tetrahedron—the solid edges represented in blue wire, and those of the enclosed octahedron in white wire; (2) the cube in blue wire, with the enclosed tetrahedron in white wire, and the hexagonal section of the cube in green wire; (3) the octahedron in blue wire, the combination of this form with the cube in white, and the hexagonal section coinciding with the edges of the latter, in green; (4) the pentagonal dodecahedron in blue, and enclosed cube in white; (5) the triangular icosihedron in blue, with contained octahedron in white. These last two are not possible crystallographic forms.

2. Wire models of the five regular solids.
1861. *Exhibited by J. R. Larkin.*

These are of 4-inch size, viz., tetrahedron, cube, octahedron, pentagonal dodecahedron, and triangular icosihedron all represented by blue wires along the solid edges.

3. Large wire model, containing an example of each species of simple form in the cubic system of crystallography, with its corresponding hemihedral forms inscribed within a sphere of the chief zone circles of the system.
1876. *Lent by Rev. Nicholas Brady, M.A.*

In this model, the lines meeting in the centre are the crystallographic axes, those of quaternary symmetry are coloured red, those of ternary symmetry blue, and those of binary symmetry green. Nineteen simple forms are represented by their solid edges. Those of the cube are coloured vermilion, those of

the octahedron and tetrahedron French blue; of the dodecahedron, emerald green; of the 3 faced octahedron and 12-faced trapezohedron, deep cadmium yellow; of the 24-faced trapezohedron and 3-faced tetrahedron, burnt sienna; of the 4-faced cube and pentagonal dodecahedron, violet carmine; and of the 6-faced octahedron, 6-faced tetrahedron, and irregular 24-faced trapezohedron, Scheele's green. Thus there are 7 holohedral and 12 hemihedral forms shown. The several zone-circles are represented by flat steel rings surrounding the forms, those which pass through the ends of the axes being coloured red, the others green, and on them are marked by dots all the poles of the chief forms of the cubic system, except those of most of the 6-faced octahedra, which lie in the triangles made by the zone circles. Made by the contributor. *See* Science Conferences, 1876, p. 430.

4. Models of crystals (16 small and 2 large) in wire, showing planes of symmetry, axes, diagonals, &c. By J. P. Stroesser.

E. 4.—1871. *Presented by the Belgian Government.*

The two large ones are:—

1. Cubic. The three axes in brass wire, and the hexakis-octahedron in the same; the octahedron in thick zinc wire.
2. Tetragonal. The axes in brass wire; combination of prism of the first order with the pyramid in thick zinc wire.

The 16 small are:—

1. Cubic, showing the trapezohedron and octahedron.
2. Cubic, showing the rhombic dodecahedron and octahedron.
3. Cubic, showing the pentagonal dodecahedron and cube.
4. Cubic, showing the 3-faced octahedron and octahedron.
5. Cubic, showing the hexakis-octahedron and octahedron.
6. Tetragonal, showing the pyramid.
7. Tetragonal, showing a combination of a prism of the first order with the pyramid.
8. Hexagonal, showing the hexagonal pyramid.
9. Hexagonal, showing the scalenohedron with the limiting rhombohedra.
10. Hexagonal, showing the rhombohedron.
11. Hexagonal, showing a combination of the hexagonal prism and pyramid.
12. Rhombic, showing the pyramid.
13. Rhombic, showing a combination of a prism of the first order with the pyramid.
14. Oblique, showing the pyramid.
15. Doubly oblique, showing the pyramid.
16. Loosely jointed wires forming a parallelopiped.

B.—*Glass Models.*

5. Four glass models, showing the principal crystalline forms contained in the cube (as arranged by Dr. Leeson) 3 in. size.
1857. *Exhibited by J. R. Larkin.*

These are cubes formed by sheet glass. The crystallographic axes are all marked by red wire. The derived forms are represented by wire edges within the cube.

1. The four-faced cube is shown by green wire, the rhombic dodecahedron by blue, the octahedron by yellow, the trapezohedron by orange, and an inner cube by red.
2. The rhombic dodecahedron in blue, 3-faced octahedron in yellow; the edges of the octahedron contained in the same are marked inside by white, and an inner cube in red.
3. The two derivative tetrahedra are marked by blue and white lines respectively on the glass, the octahedron by yellow wire, an inner cube by red and a combination of the cube and octahedron by white.
4. The trapezohedron in white, the hexakis-octahedron in blue, an inner cube in red. The edges of the rhombic dodecahedron contained in this are marked on the inside in white, and those of the octahedron in yellow.

6. Glass cube, 3 in. size.
1866. *Exhibited by J. R. Larkin.*

The crystallographic axes are marked by red wire; one derived tetrahedron by dark lines on the glass, the octahedron by yellow wire, the rhombic dodecahedron by blue, and an inner cube by red.

7. Glass cube, 2 in. size. Under small shade.
1857. *Exhibited by J. R. Larkin.*

The crystallographic axes and an inner cube are marked by red wire, the octahedron by yellow, and the rhombic dodecahedron by blue.

8. Hexagonal prism. Under small glass shade.
1857. *Exhibited by J. R. Larkin.*

The prism faces are formed of sheet glass, as are also the basal planes; the crystallographic axes are marked by red wire; the rhombohedron by white, and the corresponding scalenohedron by blue.

9. Six glass models, representing the six systems of crystallography.

1860. *Exhibited by J. R. Larkin.*

The fundamental forms or combinations are formed throughout of sheet glass, and the crystallographic axes marked by red wires.

1. Cubic. The octahedron is marked by orange-coloured wires, and the edges of the two tetrahedra are marked on the faces of the cube by blue and white lines respectively.
2. Tetragonal. The square prism of the second order with the basal planes in glass. A long pyramid marked by yellow wire, and a short one by white. The square prism of the first order is marked by dark lines on the surface of the glass, and the corresponding short prism of the second order by white lines.
3. Rhombic. The rectangular prism is in glass, the corresponding rhombic prism is marked by dark lines on the glass, and the rhombic pyramid by yellow wires.
4. Hexagonal. The hexagonal prism is in glass, the corresponding rhombohedron is marked by white wires, and the derived scalenohedron by blue wires.
5. Oblique. The oblique rhombic prism of the second order is in glass. The corresponding prism of the first order is marked by dark lines on the glass, and the oblique rhombic pyramid corresponding to the latter by brown wires.
6. Doubly oblique, the oblique prism of the second order is in glass. The corresponding prism of the first order is marked by dark lines on the glass, and the corresponding oblique pyramid by brown wires.

10. A glass cube, containing a cardboard model of a combination of a tetrahedron in blue, with a three-faced tetrahedron truncating its edges in green.

1876. *Lent by Rev. N. Brady, M.A.*

11. Models in glass (20) to illustrate the simple crystallographic forms. In cardboard box.

1886. *Exhibited by Messrs. Townson & Mercer.*

12. Glass models of crystals (30). 1¼ in. size. In two leather cases.

E. 14.—1887.

Bought of Steeg & Reuter, Homburg vor der Höhe.

13. Glass models of crystals (60), contained in two cases.

1886. *Exhibited by F. E. Becker & Co.*

Includes solids which are not possible crystalline forms, though symmetrical.

C.—*Models in other Transparent Substances.*

14. A tetrahedron in transparent mica, with the corresponding octahedron within in cardboard. The faces of the octahedron which correspond to the tetrahedron shown are coloured in dark blue, the others in light blue.

1876. *Lent by Rev. N. Brady, M.A.*

15. Models in transparent horn (34) of German manufacture.

E. 19.—1858. *Presented by the Society of Arts.*

The crystallographic axes are marked by threads within, visible through the horn. Two of them contain second forms, viz., the octahedron and rhombic dodecahedron within the cube. 10 represent the cubic system, 4 the tetragonal, 6 the rhombic, 9 the hexagonal, 3 the oblique, and 2 the anorthic.

D.—*Wood Models.*

16. Set of wood models to illustrate the five regular solids. $1\frac{1}{2}$ in. size. In mahogany box.

1873. *Exhibited by J. R. Larkin.*

17. Set of models of crystals similar to No. 16, but of 1 in. size.

1873. *Exhibited by J. R. Larkin.*

18. Set of half-inch wood models (14), in glass case, representing the fundamental forms and most important combinations in the six systems of crystallography.

1873. *Exhibited by J. R. Larkin.*

19. Models of crystals in wood (42). $\frac{3}{4}$ in. size. In mahogany box. To illustrate Dana's Mineralogy.

1874. *Exhibited by J. R. Larkin.*

20. Models of crystals in wood (40). $\frac{3}{4}$ in. size. To illustrate Ansted's "Elementary Course of Mineralogy."
1857. *Exhibited by J. R. Larkin.*

21. Models of crystals in wood (25). $\frac{7}{8}$ in. size. To illustrate Fownes' Elementary Chemistry.
1874. *Exhibited by J. R. Larkin.*

22. Models of crystals in wood (31). 1 in. size. In mahogany box. To illustrate the section on crystallography in Orr's "Circle of the Sciences."
1873. *Exhibited by J. R. Larkin.*

23. Models of crystals in wood (55). 1 in. size. To illustrate Pereira's "Materia Medica."
1874. *Exhibited by J. R. Larkin.*

24. Models in wood (36). 2 in. size. Representing different crystalline forms belonging to the cubic system. Made at Brussels.
E. 113.—1862. *Presented by the Belgian Government.*

25. Models of crystals in wood (26). $\frac{3}{4}$ in. size.
E. 94.—1857. *Made by Hachette & Co.*

These belong to the various systems, and are so fixed in a box that all their crystallographic axes are, as far as possible, parallel to each other throughout.

26. Models of crystals similar to No. 25, both in specimens and method of fixing, only the order is different.
E. 107.—1862. *Presented by the Belgian Government.*

27. Wooden models of crystals, 80 of large size, in compartments $3\frac{1}{2}$ in. by $2\frac{1}{2}$ in., in two trays contained in a box. By Stroukoff.
E. 749.—1877.
From the Pedagogical Museum, St. Petersburg.

E.—*Models in Cardboard.*

28. Collection of models of the cubic system of crystallography to a scale of three inches for the cir-

cumscribing cube, made in cardboard, and painted according to their simple forms.

1876. *Exhibited by Rev. Nicholas Brady, M.A.*

The collection consists of simple forms and common combinations, so graduated as to show the passage of one simple form into another, the intermediate forms being combinations of the two in different proportions.

Throughout the whole series the cube is coloured in red, the octahedron in blue, the rhombic dodecahedron in green. The three faced octahedron is yellow, the four faced cube is purple, the icositetrahedron is brown.

The two derivative forms produced from any of these by the same kind of hemihedrism are coloured in light and dark shades of the same colour. Thus the two tetrahedra are coloured light and dark blue, the positive by the lighter tint. The three-faced tetrahedra are yellow and orange. The pentagonal dodecahedra are light and dark purple and the two triakistetrahedra light and dark brown.

Of these models—

12 show the cube modified by an octahedron, the two component tetrahedra being indicated by the tint.

12 show the cube modified by the rhombic dodecahedron, with or without the octahedron.

6 show the cube modified by the four-faced cube and also a gradation from one simple form to the other.

10 show the cube combined with positive and negative pentagonal dodecahedra.

5 show the cube combined with the icositetrahedron.

6 show the cube combined with the positive and negative triakis-tetrahedra.

6 show the cube combined with the 3-faced octahedron.

10 show the cube combined with the positive and negative 3-faced tetrahedra.

24 show the octahedron and its derived tetrahedra in combination with each other, and with the rhombic dodecahedron.

18 show the octahedron or tetrahedron combined with the icositetrahedron or its hemihedral forms.

6 show the octahedron or tetrahedron combined with the 3-faced octahedron.

20 show the octahedron or tetrahedron combined with the hemihedral forms of the 3-faced octahedron and icositetrahedron.

15 show the rhombic dodecahedron with the 4-faced cube, and its derived pentagonal dodecahedra.

22 show the rhombic dodecahedron with the positive and negative 3-faced tetrahedra.

3 show the rhombic dodecahedron with the icositetrahedron.

15 show 3-faced octahedra of various parameters with the derived tetrahedra.
9 show 4-faced cubes of various parameters.
16 show pentagonal dodecahedra of various parameters with unequal combinations of the two.
12 show icositetrahedra of various parameters.
9 show the two derived triakis-tetrahedra, and their unequal combinations.

29. Collection of models of the rhombohedral system, with its holohedral, hemihedral, and tetartahedral forms.
1876. *Lent by Rev. Nicholas Brady, M.A.*

In this collection the faces are coloured uniformly throughout. The basal planes are white. The rhombohedral or pyramidal forms are coloured pink, light green, light yellow, or light blue, according to their relation to the axes chosen. The prismatic faces into which these rhombohedra pass respectively are distinguished by darker tints of the same colours.

30. Cardboard models of crystals of various systems. 2 in. size.
1876. *Lent by Rev. Nicholas Brady, M.A.*

16 of these represent tetrahedra, their modifications by various other forms, and their twins. They are coloured light and dark blue according as they are positive or negative.
6 show rhombic pyramids and their modifications, also in blue.
2 show oblique pyramids. One pair of faces coloured white.
5 show prismatic forms. The rectangular in red, oblique in brown, and doubly oblique in pink.
1 shows the rhombic dodecahedron in green.

F.—*Crystal-Nets for making Cardboard Models.*

31. Models of crystals in cardboard (39) illustrative of the crystalline systems.
1876. *Exhibited by J. B. Jordan.*

These are coloured according to the system to which they belong. The cubic forms (11) are pink, &c. The tetragonal (6) are orange. The rhombic (6) are brown. The hexagonal (6) are green. The oblique (5) are blue, and the anorthic (5) are grey.

(Note, the systems are called respectively by the author the tesseral, tetragonal, rhombic, hexagonal, monoclinohedric, triclinohedric.)

32. Nets for the construction of the models, No. 31. 9 sheets. Published by Thos. Murby.
1876. *Exhibited by J. B. Jordan.*

G.—*Miscellaneous Models, &c.*

33. Models of natural crystals of diamonds.
1877. *Exhibited by the late R. Damon.*
12 glass models in a case.

34. Models of the most celebrated precious stones.
1877. *Exhibited by the late R. Damon.*
28 glass models in a case.

35. Models to illustrate the colours of various gems. As used in Austrian schools.
1882. *Exhibited by H. J. Gehlsen & Co.*
24 coloured glass models, cut in rose form, in a box.

2. Instruments used in Mineralogical and Geological Researches.

A.—*Goniometers.*

36. Large goniometer and spectrometer, with heating apparatus to allow of the examination of crystals at high temperatures, and case of accessory apparatus.
E. 84.—1885. *Made by R. Fuess, Berlin.*

This instrument is arranged for the observation of the angles of crystals with extreme accuracy, and the changes they undergo with changes of temperature.

It consists of a tripod, with three levelling screws, the centre of which is perforated and encloses a vertical cylinder, which supports at the top a horizontal divided circle, which can be rotated by means of the large screw beneath the table of the tripod, or by another large parallel screw below, which is bound to the first by upright bars. The fine adjustment is effected by a tangential screw on an arm projecting from beneath the tripod table, and it is clamped in position by a radial screw on the same arm. Through the centre of this cylinder passes a smaller cylinder, independent of the first, and carrying the central support. This can be rotated by the uppermost of the smaller screws beneath the tripod table, which

has also a fine adjustment and clamping screws in connexion. This contains in its centre a vertical rod, on the top of which the support for the crystal is fixed, and which can be raised or lowered by means of the lowest of the small central screws below the tripod table. The support for the crystal consists at the base of two plates, one over the other, which can be moved horizontally in two directions at right angles to each other by means of screws at the sides. To the uppermost of these are fixed two circular arcs one above the other, the upper one having a table to which the crystal is fixed. These arcs are worked by screws at the sides, so that each rotates about an axis lying a little above the topmost table, and therefore somewhere near the edge of the crystal to be examined. The axes of rotation of the two arcs are at right angles. By these arrangements the crystal may, within certain limits, be placed in any desired position, and moved from one position to another.

The several cylinders work in a vertical projection from the tripod table, on the outside of which are two movable supports for the telescopes, &c. Each of these supports consists of a central ring which works on the projection, to which is fixed on one side a radial arm for the telescope, and on the other a counterpoise. The telescope arm may be rotated by a small projecting handle, and below there is a second arm also connected with a central ring, which has a tangential fine adjustment screw, and a radial clamping screw. The telescopes are fixed on vertical supports, and each is provided with a peculiar form of cross wire, and also an analyser, to which is attached a graduated circle for use with polarised light. A light signal, fixed in the neighbourhood of the instrument, is reflected from one face of the crystal under examination, and its image is brought to the cross-lines of the telescope by the rotation of the latter. The exact position of the telescope is then determined by the microscope above. This microscope is fixed behind the objective of the telescope, the tube being pierced, the objective of the microscope is focussed opposite the divisions of the horizontal circle, which are at a distance of 10′ apart. It is illuminated through an oblique cut at the side. The rays pass upwards to a prism within which they are totally reflected and enter the ocular of the microscope, which is provided with two parallel threads. The ocular portion of the microscope can be moved horizontally by means of a screw just above the telescope, so as to bring the threads to coincidence with the 10′ divisions. The amount necessary to do this may be determined by the graduation of the micrometer screw, which may be read to $\frac{1}{600}$ of its circumference, and thus 1″ of arc on the horizontal circle determined.

For a further description of this instrument see Groth, Physikalische Krystallographie, 2nd edition, 1885, p. 567, fig. 578–9.

37. Apparatus for examining crystals at a high temperature.

E. 84A.—1885. *Made by R. Fuess, Berlin.*

Consists of a metal box, supported on two uprights with three windows in the central part, one for the light from the signal to enter and the other two for the telescopes. The box has a circular perforation below to fix over the adjusting portion of the goniometer; its two ends are provided with hollow tubes of iron to be heated in Bunsen burners, thereby heating the air within the box and thus also the crystal, which is held by a pair of pincers in the centre. The temperature is read off by two thermometers fixed in perforations on the top.

38. Wollaston's reflecting goniometer.

E. 85.—1885. *Made by R. Fuess, Berlin.*

In three separate parts fixed to a marble stand. One part is a mirror turning about an axis; opposite to this is the telescope, sliding parallel to the same axis and provided with cross wires in the eye-piece. The third is the silver graduated circle with vernier and telescope, with the crystal holder rotating on the same axis on an inner tube and provided with two screws at right angles to the axis for adjustment.

39. Wollaston's reflecting goniometer, belonging to and used by the late Dr. Whewell, D.D., F.R.S., Master of Trinity College, Cambridge, when Professor of Mineralogy.

1876. *Lent by Rev. Nicholas Brady, M.A.*

Early form, such as that described by Bauerman (Systematic Mineralogy, p. 192), and in most treatises on Mineralogy.

40. A simple substitute for a goniometer.

Contrived by the late Professor W. H. Miller, Cambridge.

1876.

The instrument consists of a long piece of wood with smooth sides, to one end of which is screwed a vertical piece of brass wire bent horizontal at the top and passing through a cork. Through this cork is passed another horizontal brass wire at right angles to the first, and its end is bent down vertically, and passes into a third cork; all these are movable about their axes, so that a crystal fixed to the third cork can be turned about three axes at right angles and made to take up any position. By means of this a crystal can be measured by Wollaston's method, and the angle of an edge determined by the determination of the angle between two lines drawn on paper along the wooden part of the instrument in its two different positions.

41. Contact goniometer.
E. 87.—1885. *Made by R. Fuess, Berlin.*

Consists of a broad steel arc graduated from 0° to 90°, the same subdivisions being also marked from 90° to 180° for convenience; radially to this are two bars with straight edges overlapping in the centre, the one is fixed at 0° and the other is movable by means of a carrier fitting over the arc, the straight edge of which passes over the subdivisions. Both arms slip in a radial direction in their sockets.

42. Contact goniometer.
E. 86.—1885. *Made by R. Fuess, Berlin.*

A silvered brass circular flat ring, graduated to degrees. Flat radial bars slide in slots in the direction of their length, and can then be fixed so as to move only about the centre. The index and arms are of steel, and both arms are movable.

B.—*Instruments for investigating the Optical Properties of Minerals.*

43. Haidinger's dichroiscope.
E. 90.—1885. *Made by R. Fuess, Berlin.*

At one end of the tube is a convex lens to which the eye is applied; at the other, a small square hole; between them is a rhombohedron of Iceland spar, so cut that the two surfaces are opposite rhomb faces, the shorter diameters of which are parallel to the median plane of the tube. The thickness is so chosen that the two images of the square aperture seen through the lens at the other end may lie side by side. When a plate of crystal in which the ordinary and extraordinary rays are separated is placed before the aperture, the one image formed by the dichroiscope when its axial plane is parallel to that of the crystal, will be formed by the ordinary and the other by the extraordinary ray. If there is any difference in colour or intensity between these, as they are side by side it may be immediately perceived.

44. Brezina's stauroscope.
E. 89.—1885. *Made by R. Fuess, Berlin.*

An apparatus for determining the positions of the planes of vibration in crystal sections, by their coincidence or otherwise with the planes of vibration in the polarizer or analyzer. The instrument is vertical and consists of a tube carrying lenses above, and another tube carrying lenses for illuminating the object from below. The stage rotates and is graduated, and there is a concave reflector on the stand. The polarizing portion consists of a

nicol as polarizer, and a second nicol as analyzer, which carries a graduated circle and contains the essential part of the instrument. This is the plate fixed below the analyzer, consisting of two slices of calcite cut nearly, but not quite, perpendicularly to the axis, and placed one over the other, so that their optical axes lie in the same plane but yet do not coincide. These produce, when viewed alone, an interference figure of peculiar form, with a straight arm of a cross through the centre. When, however, a crystal plate is laid on the stage, unless its plane of vibration coincides with those of one or other of the nicols, this figure is altered by the dislocation of the central part of the arm of the cross. The amount of rotation necessary to restore the figure, and so make the planes of vibration coincide with those of the nicols can be measured on the graduated stage.

45. Kohlrausch's total reflectometer, with improvements by Klein.

E. 145.—1886. *Made by W. Apel, Göttingen.*

This instrument is devised for the purpose of determining the refractive indices of crystalline minerals and other substances by comparing them with a fluid of known higher refractive index. It consists of a triangular foot with the sides hollowed out so that a source of light may be brought quite close to the centre and on one side an upright beam, to the summit of which is fixed, by a horizontal side support, a circle graduated in half degrees and movable about a central axis, and with a fine adjustment screw at the side. The readings are made by two magnifiers and verniers. To the under side of the circle opposite the vertical beam is fixed a horizontal telescope at the end of a vertical arm. A glass jar, one side of which has a piece of plate glass fixed vertically against it, is filled when in use by the dense liquid employed, either carbon bisulphide, or bromnaphthaline, and is supported in slots on the under side of the horizontal ring, so that when placed in position the plate glass is opposite the telescope. Through the centre of the axis of the horizontal circle runs a vertical bar, which is attached below by a pair of ball and socket joints to the crystal carrier, and is movable up and down in its socket until fixed by a screw near the top. This crystal carrier is a circular frame, to the surface of which the crystal may be attached, and which is rotated by means of an endless screw working on its circumference and attached to a rod with a Hooke's joint passing through an aperture in the horizontal circle. The object of these arrangements is to place the surface of the crystal to be examined in the same plane as the axis of the circle, to test which a mirror is attached to the outside stem of the instrument, to which it must be placed optically parallel. From the centre of the base of the instrument stands up a paper holder in the shape of a double arc, and which may be turned about its axis. The source of light is placed behind

this paper so as to produce a diffused light. When the crystal is in place in the denser fluid, only those rays which have less than a certain obliquity can enter the crystal, the rest are "totally" reflected and enter the telescope, one of whose cross lines is brought to coincidence with the sharp line marking the limit of total reflection, and its position is read on the horizontal circle. The light is then transferred to the opposite side of the instrument and the limit on that side observed in the same way. Half the angle between these two positions is the limiting angle of incidence whose sine is the index of refraction between the crystal and the surrounding fluid; the latter being known the refractive index in air of the crystal can be obtained at once. The accessory apparatus consists of extra glass holders, a condenser on stand, a thermometer to test the temperature of the enclosing fluid which will affect its refractive index, &c.

46. Norremberg's polarizing apparatus. Specially adapted for crystallographic work. Can also be used as a goniometer.

E. 13.—1887. *Made by Steeg and Reuter.*

This consists of a vertical fixed bar to the lower part of which is fixed a pair of mirrors each movable about a horizontal axis for polarizing the light. Three tubes slide by means of side sockets on the upright bar, and can be fixed in any given position by screws. The lowest contains a series of converging lenses; the middle a series of magnifying lenses. Between these two tubes the crystal section is laid. The upper tube contains a nicol and is graduated on its circumference. There is also a separate fitting to act as a goniometer.

47. Polariscope with lens for parallel light and a large nicol, for measuring the angle between the axes.

E. 87.—1877. *Made by L. Laurent, Paris.*

On the same principle as the Norremberg polariscope. It has a tripod with a movable joint to the upright, so that the instrument can be put at any angle; it has two mirrors for polarizing, and a graduated stage.

48. Groth's universal apparatus for crystallographic optical research.

E. 37.—1884. *Made by R. Fuess, Berlin.*

This apparatus consists of several parts, which can be fitted together in various ways for various purposes.

First, there is a vertical stand, on the horizontal base of which is placed a rotating mirror; on the upright bar two carriers slide, each of which may be clamped by a screw. Into the circular apertures of these slides fit two pairs of polarising apparatus. The one pair for parallel light consists of (1) the polarising part,

to fit into the lower carrier, having a large nicol between two moderately convex lenses, and a centrally perforated cap to support the crystal, so arranged that the boundary of the perforation points to 90° on the graduated rim; (2) the analysing part consisting of a small nicol at the ocular end, and diaphragms at both ends, having minute central apertures to ensure the parallelism of the light. On the upper end of this fits Calderon's stauroscope, consisting of the two halves of a rhombohedron of calcite cut through the short diameter, which are then placed so as to form an artificial twin, and ground into a plate, which thus consists of two halves divided by a plane. When this plane is parallel to the principal section of either nicol, the two halves have the same tint, but when a crystal intervenes they will have different tints, except when the plane of polarisation in the crystal coincides with the principal plane of a nicol. The other pair, for convergent light, consists of a polariser having a large nicol with a single lens below, but a combination of five lenses above and a crystal holder of wide aperture. The analyser has a combination of four lenses at the objective end, above which is a glass micrometer, which is rendered visible at the same time as the interference figures by means of an ocular lens, which is surmounted by a small nicol, a slit being made between the two for the insertion of quartz wedge or a quarter-undulation plate.

Secondly, there is a double stand, the uprights of which are enlarged near the base into two rings, into which fit the two parts for convergent polarised light just described. The uprights are continued upwards as supports for a horizontal divided circle with its appendages. This portion may be arranged first as an axial angle measurer. When so used the analyser and polariser are fixed horizontally in the tubes, leaving only so much interval between them as to allow of the crystal being rotated. The crystal to be examined is suspended from the centre of the horizontal circle. The suspender works in an externally conical tube, which can be clamped to an upright from the circle. Within this tube works a vertical shaft by which the crystal may be raised or lowered, and this can be clamped to a projecting piece which works in a narrow horizontal box below the circle, so as to place the crystal in any position horizontally. The shaft ends downwards in a Petzval's holder, or shallow curvilinear box, in which a curvilinear process connected with the crystal carrier below can work tangentially, the centre of the circular arc being about where the centre of the crystal will be, which may thus be adjusted to its proper orientation parallel to the faces of the nicols. When it is in position it is clamped to the circle, and a reading taken by two verniers. The angular distance through which the circle has to turn to bring one axis after the other into the centre of the field of the analyser can then be read. If the angle is to be measured in oil the oil carrier is placed on the small table between the uprights. If it is to be measured at a high temperature the enclosing box is put on the same support. This box is a long

parallelopiped, at the opposite ends of whose short diameter are two windows on telescopic bearings to allow of the crystal being seen; the long diameter is set perpendicularly to the polarisers, and the ends are heated, the temperature attained being determined by two thermometers inserted into holes in the box.

The rotation of the plane of polarisation by any given thickness of crystal is measured by the same portion of the apparatus, only that the polarisers for parallel light are inserted in the rings instead of those for convergent light. The ring to contain the analyser has a vertical divided circle, over which a vernier on the analyser works, and thus the angle through which this has to turn to counteract the effect of a crystal plate between it and the polariser can be read.

The horizontal circle has further attachments for other purposes. When it is to be used as a goniometer two telescopic tubes are affixed to verticals attached to horizontal radial arms, which work on pivots fixed below the circle, and are of such a length as to allow each tube support to pass freely all round the circle, to which each may be clamped in any particular position. One of these tubes is a telescope with cross lines; the other contains a peculiar form of aperture, called Websky's, to admit the light in a definite direction. The centre of the table is perforated, and through it passes an arrangement for fixing the position and orientation of the crystal to be observed as in the large Fuess's goniometer already described.

When it is to be used to measure the index of refraction of a prism, the rotating arm of the telescope is reversed in position, and is clamped to the rotating arm of the table, so as to rotate with it; the light signal is made to rotate about the axis of the instrument, and the adjusting arrangement in the centre is set free from its clamps, and may be rotated so as to set the prism in the position of minimum deviation; contrivances for carrying out all these changes are provided in the instrument.

49. Apparatus for demonstrating double refraction by pressure.

E. 92.—1885. *Made by R. Fuess, Berlin.*

This consists of a screw vice with convex cheeks, which, by means of the screw, can be made to compress a crystal placed in the jaws of the vice, and this can be examined when so placed.

50. Apparatus for producing double refraction by pressure.

E. 91.—1885. *Made by R. Fuess, Berlin.*

This is also a screw vice, but it is so arranged as to measure the pressure applied. The screw end has projections to come in contact with the crystal, or its holder, and forces it against a movable cheek on the opposite side. This slides between bars, and when no pressure is applied, stands at 0; but behind it is

a strong spiral spring, the compression of which measures the pressure employed, by means of a graduation on one of the bars from 0 to 50 kilograms.

51. Apparatus for demonstrating double refraction by flexure.

E. 93.—1885. *Made by R. Fuess, Berlin.*

This consists of two pieces of plate glass, screwed together at the two ends. When it is to be used for the purpose named, a metal rod is placed crosswise between the plates of glass at the centre, and the two screws on either side are made to draw the ends together. By this means the glass is bent, and the double refraction is observed.

52. Apparatus for demonstrating double refraction by heating.

E. 94.—1885. *Made by R. Fuess, Berlin.*

This is merely a handle with a spring lever on one side, and at the end, two rectangular holders of such a shape that when closed they leave a cubical space within, by which cubes of glass may be taken up, heated, and put down again on a stage for examination; with this holder are 12 glass cubes to be used for the purpose.

53. Crystals for heating.

E. 79.—1877. *Prepared by L. Laurent, Paris.*

These are sections of crystals with parallel faces fitted on to tongues of brass, with perforated plates, between which the crystal is placed and secured by screws, when it can be heated. The specimens are, Felspar, Gypsum, Carbonate of Lead.

54. Collection of plates of crystals (31) containing uniaxial and biaxial species. Prepared for examination with the polariscope.

E. 17 to 47.—1885. *Prepared by B. Stürtz Bonn.*

These are selected from a larger list, with numbers attached, corresponding to their position in that list. The selected types are:—

Uniaxial Crystals.

17. Quartz, left handed.
18. Quartz, right handed, 4 mm. thick.
19. Dioptase, Siberia.
20. Quartz, 8 mm. thick.
21. Brucite, Texas.
22. Apophyllite, Poonah.
23. Zircon, Ceylon.
24. Apatite, Tyrol.
25. Beryl, Brazil.
26. Corundum, Ceylon.
27. Calcspar, $\frac{1}{2}$ mm. thick.
28. Calcspar, 1 mm. thick.
29. Calcspar, 3 mm. thick.
30. Calcspar, hemitrope.
31. Meionite, Vesuvius.
32. Tourmaline, Elba.

Biaxial Crystals.

33. Adularia, S. Gothard.
34. Anhydrite.
35. Aragonite, Bilin.
36. Axinite, Oisans.
37. Barytes.
38. Celestine, Erie.
39. Diopside, Tyrol.
40. Disthene, S. Gothard.
41. Epidote, Tyrol.
42. Mica.
43. Gypsum, Sicily.
44. Labradorite.
45. Cryolite, Greenland.
46. Topaz, Brazil.
47. Cordierite.

C.—*Petrographic Microscopes.*

55. Petrographic microscope. Designed by Professor H. Rosenbusch, of Heidelberg, and described by him in the Neues Jahrbuch für Mineralogie, 1876.

E. 88.—1885. *Made by R. Fuess, Berlin.*

This is interesting as being one of the earliest microscopes which were constructed for purely petrographical investigation. It has the ordinary horseshoe stand of continental microscopes, but is fixed in a vertical position. It has a sliding coarse adjustment, and reflector on a crank arm. It is provided with three of Hartnack's objectives, Nos. 4, 7, 9, three eyepieces, and a lamp. Its distinct petrographical features are as follows:—It has a polariser easily thrown in and out of position, and the analyzer which fits over the eyepiece has a graduated ring, whose zero corresponds to the crossing of the Nicols. The stage rotates, and is graduated in degrees on the circumference, and along two lines at right angles on the surface in millimetres, for the purpose of recording the position of any spot in the slide examined. The accurate centring of the ocular portion, so that its axis may pass through the centre of rotation of the stage, is secured by means of a second tube outside the first which supports the inner by springs, and contains two screws, which work near the end of the tube carrying the objective, so as to move the latter in either or both of two horizontal directions at right angles to each other. Two eyepieces are provided with cross lines. The fine adjustment has a graduated circle. There is a slit in the side immediately above the objective, for the insertion of a quartz plate or wedge, and there is also a calcite plate to fit over the eyepiece. An apparatus for heating sections during examination consists of a long hollow metal box, at one end of which is placed a lamp within a mica shade, by means of which the air within the box is heated, and communicates its heat to the slide, which is placed over a perforated disc in the centre, the perforations being covered by glass and a thermometer with a branched bulb, placed with one branch on each side of the object. To this instrument a Bertrand-Lasaulx combination

has been added to be placed over the polariser to render the light strongly convergent for producing interference figures in the crystal.

56. Fuess's petrographic microscope.
E. 38.—1884. *Made by R. Fuess, Berlin.*

This is of the same general type as the last, but of larger and improved form. It is provided with four objectives, No. 3, 5, 7, and 9, which are attached to a revolving nose-piece at the bottom of the microscope tube. This prevents any vertical motion of the tube in its holder, and consequently the coarse adjustment is made by means of screw and rackwork near the base of the stand which raises the stage and its attachments. The fine adjustment reads to ·001 mm. The stage is divided as before, but has a vernier reading to 5′.

The centring of the axis of rotation is brought about by adjusting the stage instead of the objective. This is done by means of two screws working at right angles. One of these has a graduated milled head, so as to serve as a micrometer whose subdivisions correspond to ·002 mm. The polariser as well as the analyser has its circumference graduated, and can be raised or lowered in its containing tube by means of a screw. There are four eyepieces, one of which is provided with a Calderon's stauroscope, as described in Groth's universal apparatus, instead of the cross lines. The instrument has also Bertrand's system of lenses for magnifying the interference figures, a Biot-Klein's quartz plate, a quartz wedge, a Bertrand-Lasaulx combination for producing strongly convergent light, and an apparatus for determining the critical points of liquids enclosed in cavities of minute crystals, similar to that for examining heated crystals.

57. Petrographic microscope.
E. 115.—1886. *Made by A. Nachet, Paris.*

This is the instrument recommended by MM. Fouqué and Michel Levy in their Mineralogie Micrographique, Paris, 1879, where its chief features are described.

It is supported on two uprights on the usual horseshoe stand, and rests on a horizontal axis, about which it can be inclined. There are two superstages which move in two directions at right angles over graduated surfaces, so that the position of any object on the slide can be recorded. The principal feature of this microscope is the separation of the objective and eyepiece, which are attached to distinct tubes. The objective carrying tube is connected by an upright with the stage itself. Its position on the upright is controlled by coarse and fine adjustments, and the whole rotates together. Thus the necessity for centring is entirely done away with, the polariser being on a distinct support. The

stage is graduated, is provided with vernier, and has also two rectangular motions. It can be rotated by hand or clamped, when it is rotated either way by an endless screw working on its circumference. The ocular portion is supported by an outer upright, and has its own adjusting screw. The analyser is placed in a slit in the base of the tube, so as always to be in a fixed position when in use, but can be removed by turning about a hinge, but the polariser rotates. The cross lines of the eyepiece are illuminated when the nicols are crossed by a small side mirror, and in the base of the ocular tube a Bertrand lens is fitted, which can be focussed by means of a screw. Six objectives, one of very long focus, which may be rapidly attached by a spring arrangement are supplied with the instrument. It has also the Bertrand-Lasaulx combination for producing strongly convergent light, and the usual quartz wedges, &c. to fit into a slit above the objective. The accessory apparatus consists of two extra eyepieces, three additional lenses, a right angled prism, forceps, six quartz-plates, a stage micrometer, and condensing lens on stand.

58. Petrographic microscope designed by Prof. C. Klein of Göttingen.

E. 127.—1886. *Made by Voigt and Hochgesang.*

This stand is on the usual horseshoe base, on a short upright support, about which the upper part turns on a horizontal axis. The stage is graduated to half degrees, and there is a vernier of 30, making the reading to minutes. It is rotated coarsely by hand, or slowly by a tangential screw. The polariser, which is graduated to 5°, slides into its carrier and then may be elevated or depressed by a screw. Over the polariser the Bertrand-Lasaulx condensing lenses provided may be fitted also. Diaphragms are provided to fit the same carrier. There are two circular superstages, with motions in perpendicular directions, effected by means of screws with graduated heads. The surface of the upper one is also graduated in directions parallel to the motions, by which means the position of an object can be recorded. Each turn corresponds to $\frac{1}{2}$ mm., and the graduation is to 50 parts, so that the arrangement serves as a micrometer reading to ·01 mm. The coarse adjustment is by rack and pinion, and the fine by a large screw head working vertically and graduated into 250 parts each corresponding to $\frac{1}{2}$ mm. descent, so that a thickness of ·002 mm. may be determined. The objectives are centred by two screws at right angles. The analyser fits over the eyepiece and is graduated to 5 degrees. There is also a second fixed analyser which slides into the tube near the objective. Into the same slot slides a Bertrand lens, and both may be raised or depressed by a screw. Below there is a slit to receive a quartz-plate, quarter-undulation-plate, mica-plate, or selenite-plate, of such a thickness as to give the red of the first order, which are provided. There are six objectives, Nos. 1, 2, 4, 5, 7, and 9 of

Hartnack's, and six oculars, two with micrometers, Calderon's stauroscopic plates in one, Bertrand's quartz plate stauroscope in another, and two with simple cross lines. There are supplied also an objective micrometer, reading to ·1 mm. and additional condensing lenses and diaphragms.

59. Petrographic microscope.
E. 68.—1888. *Made by Seibert, Wetzlar.*

Usual horseshoe stand with tube rotating about a horizontal axis. The stage is graduated and rotates. The centring is effected by screws working on the stage, as in Fuess's model. The polariser slides in, and is graduated. Over it is placed the condensing lens, and diaphragms are provided to fit in the same place. The coarse adjustment is by rack and pinion with one screw only; the fine adjustment, by a screw working vertically from the base, with a graduated head. The analyser is placed in a slot, and does not rotate, but is removable, and the gap in the tube closed by a revolving shutter. Above the analyser is a rising and falling tube within the main one, with a slot at the bottom to receive a Bertrand lens, which is thus adjustable. Four eyepieces with cross wires are provided, and a second analyser fitting over the top with a graduated circle. There are five objectives, Nos. 1, 2, 4, 5, and 7, an additional Bertrand lens, an extra lens to fit over the polariser, a box of selenite and quartz plates, a thick plate of calcspar, and two test objects.

60. Petrographical microscope. *Price*, 17*l.*
1887. *Exhibited by J. Swift and Son.*

English tripod stand, with tube rotating about horizontal axis. The stage is glass-covered and has a rim reading to 5′. Polariser on a crank arm, rotating with slot for fixed position, graduated, but not capable of vertical motion. A set of converging lenses are provided to fit over it. Coarse adjustment by rack and pinion, fine adjustment with graduated head. Optical tube fitted with a nosepiece for the two objectives 1 in. and ¼ in. provided. The main analyser fits into a slit near the base of the tube. Below it is a slit for inserting a quartz plate. The eyepiece has cross wires, and over it fits another analyser with graduated rim, below which is an arrangement for inserting, rotating, and removing a calcite plate.

61. Petrographical microscope.
1888. *Exhibited by Watson, Bros.*

English tripod stand, with body movable about a horizontal axis, and has an arrangement for fixing the tube in a horizontal position. Has a large polariser on a crank arm with graduated edge with lens, and extra condensing lenses fitting on above; has a circular stage, with rim divided to half degrees with vernier. Can be centred by use of a key; superstage movable in one direction. Fine

adjustment in front; coarse adjustment by rack and pinion. A slot above the objective for the insertion of quartz-plate, quarter-undulation-plate, and Bertrand-lens, which are provided. The analyser fits over the eyepiece, which is of low power and provided with a graduated circle, and an additional eyepiece is provided. There are three objectives of $1\frac{1}{2}$ in., $\frac{2}{3}$ in., and $\frac{1}{4}$ in. focus. The accessories are a condenser on stand, a live box, stage and hand forceps.

D.—*Petrographic Microscopes for Students.*

62. Petrographic microscope.
E. 116.—1886. *Made by A. Nachet, Paris.*

As in the larger microscope, the stage and objective rotate together on a separate support, with focussing screw. The ocular portion slides in its tube. The stage is graduated and rotates, but there is no superstage. It is fixed in a vertical position, and is not capable of inclination. The polariser is on a crank arm, and has a weak converging lens over it. The analyser fits over the eyepiece, which has cross wires and is not graduated. A second eyepiece is provided, and three objectives, Nos. 3, 5, and 7.

63. Petrographic microscope.
E. 69.—1888. *Made by Seibert, Wetzlar.*

The polariser is on a sliding plate. Has a graduated rotating stage, diaphragms, and converging lens. The optical tube slides in a sheath, and the graduated fine adjustment is at the top. The analyser fits over the eyepiece, and is coarsely graduated. There are no slots in the side of the tube. The instrument is fixed in a vertical position, and is not capable of inclination. Two objectives and three eyepieces are provided, with a second condensing lens. Selenite and quartz plate, and three test objects.

64. Petrographic microscope.
1888. *Exhibited by Watson Bros.*

English tripod stand; body movable about a horizontal axis, and with a stop to indicate when it is in a horizontal position. Has a large polariser on a crank arm, graduated to 45°; a circular graduated glass-topped stage; coarse and fine adjustment not graduated. Analyser to fit over eyepiece, not graduated; cross lines to eyepiece; has 1 in. and $\frac{1}{4}$-in. objectives. Condenser on stand. Live box and forceps.

65. Star microscope. *Price, 6l. 15s.*
1891. *Exhibited by R. and J. Beck.*

Has a triangular base, with oblique support, with a horizontal axis, about which the microscope rotates. Has a circular

rotating stage, graduated to degrees. The polariser is on a crank arm, and has spring catches to fix its diameter at right angles to that of the analyser. The centring is secured by screws working at right angles on the objective holder. The eyepiece has cross lines, and is fixed by means of a slot. The analyser, which is graduated, fits over it and can be rotated, and has spring catches to indicate the crossing with the polariser. It has rackwork coarse adjustment, and micrometer screw fine adjustment, not graduated. It is supplied with 1 in. and ¼ in. objectives. This instrument can also be provided with a set of converging lenses to produce the interference figures, and is sometimes made with a slit for the insertion of a quartz-plate and quarter-undulation-plate above the objective.

66. Petrographic microscope with inclinable tube on bronzed tripod stand. *Price* 8*l.* 8*s.*
1889. *Exhibited by H. Crouch & Co.*

The polariser is carried by a crank arm; the analyser is contained in a block, which slides in a slot above the objective.

The stage rotates, and is graduated.

One eyepiece is supplied, which is fitted with an indicator; and a revolving double nose-piece carries a ¼ in. and 1½ in. objectives.

E.—*Apparatus for cutting Sections of Minerals and Rocks.*

67. Lapidary's wheel for cutting large specimens.
E. 39.—1884. *Made by R. Fuess, Berlin.*

This is adapted for cutting sections several square inches in area. It has a heavy cast-iron stand and plain wood treadle. The axle of the wheel is attached to one side only of the stand; the diameter of the wheel is about 22 in. The upper part of the casting consists of two broad parallel bars, leaving a groove between, which is edged with steel, and along which the movable parts can slide and can be fixed by nuts below. The first of these movable parts consists of the small wheel, with a diameter of 6 in. on a double horizontal support, the other end of its axle carrying the vertical slitting disc, round which, except near the base is a loose tin case. The second movable piece is the rock carrier. This consists of a platform fixed on the short arm of a lever, whose fulcrum rests on the slider, and to which it can be secured by nuts. It can thus be fixed in any required horizontal position, and it can also be raised or lowered for changing the vertical position. The other end of the lever is a long bar carrying cylindrical sliding weights, by which the upward pressure of the platform end can be modified at pleasure. On

this platform are two screws fixed in position at one end, and at the other is a movable toothed bar, which slides up and down in a slit, by which means the rock to be cut may be held firmly between three supports. There is also a square box, provided with wax, to which to fix smaller specimens. These movable parts have beneath them a zinc tray, perforated where necessary. There is no arrangement for polishing the sections.

68. Apparatus for cutting and grinding rocks and fossils for microscopical examination.

E. 49.—1885. *Made by R. Fuess, Berlin.*

This is adapted for cutting sections of a not greater diameter than 1½ inches. It has the same form as No. 67, but on a smaller scale. The arrangements for rotating the vertical slitting disc are identical, but the tin covering is more open, the specimen to be cut being brought to the slicer from the side and not from below. The rock holder as before is on a lever worked in the same way by two forked weights moving on the longer arm, but instead of being a platform it consists of a vertical bar movable and clampable in its own direction. At the end it carries a second bar, movable through it in a horizontal direction, and this carries a third bar movable through it in another horizontal direction at right angles, to the end of which is fixed a circular disc, 1½ in. in diameter, to which the rock specimen is cemented. These arrangements allow of the placing of the specimen in any desired position in relation to the slitting disc. But as in all positions the face of the supporting disc is parallel to the surface of the slitting disc, the specimen must be orientated with the surface of the support in the process of cementation. There are additional cutting discs of various diameters. The grinding portion of the apparatus consists first of a pair of wheels fixed obliquely on the under side of the horizontal framework, by passing the cord round which the vertical is converted into a horizontal rotation, which revolves a polishing lap, protected by a zinc tray. An extra lap is provided with the machine.

69. Machine for cutting slices of rocks and fossils, to work by hand.

E. 40.—1884. *Made by R. Fuess, Berlin.*

This stands on an 8 in. square wood block; the motion is produced by turning a vertical cogwheel by the projecting handle. This cogwheel is about 10 in. in diameter, and works into another about 1½ in. diameter. To the latter is fixed a vertical slicing disc with a tin protector. The specimen is held in its place by the same leverage arrangement and sliding bars as in No. 68, but the whole is on a smaller scale. There is no arrangement for polishing.

70. Amateur's lapidary machine for slitting, grinding, and polishing. Designed by J. B. Jordan. *Price* 12*l.* 12*s.*
1884. *Exhibited by Cotton and Johnson.*

This consists of a mahogany framework similar to that of an ordinary lathe, and is supplied with crank, heavy fly-wheel about 24 in. diameter and treadle occupying a floor space of 24 in. by 15 in. To the bed of this frame is fitted an iron casting bored to receive two spindles, viz., a vertical spindle which carries the slitting disc, grinding laps, &c., and another spindle to which is fixed a horizontal plate carrying on its surface a cup containing cement into which the material to be cut is embedded, and which is retained and uniformly pressed against the slitting disc by means of a cord attached to the plate near its edge, which, passing over a pulley, supports a weight which gives a constant and regular pressure. This plate can be raised or lowered as required by means of a screw below the bearing. Horizontal motion is given to the slitting disc by means of two obliquely-set wheels below the bearing, over which the cord passes to a horizontal wheel. When the machine is required for grinding, &c., the slitting disc is removed and the laps, of which three are provided, are fixed in its place. The whole of the upper part is underlaid by a zinc tray, perforated in the centre for the axles. At the side, on a movable ledge, stands a water vessel with tap, by which the disc or lap can be kept perpetually moistened.

71. Apparatus used in grinding and mounting rock sections for examination under a microscope. With the apparatus is shown a series of slides in different states of preparation.
Lent by the Geological Laboratory, Royal College of
1887. *Science.*

These consist of emery of four degrees of fineness, the finest being previously washed; Bunsen's burner, tripod, iron-plate, soap solution, Canada balsam, watch glasses, 1½ in. squares of thick glass, glass slips, and round cover glasses.

F.—*Apparatus used in Blowpipe Analysis.*

72. Letcher's blowpipe cabinet. *Price*, 34*s.*
1886. *Exhibited by J. Orme & Co., late M. Jackson.*

As arranged for the Society of Arts, in a mahogany case.

73. Letcher's blowpipe case. *Price*, 21*s.*, *in a box.*
1880. *Exhibited by T. H. & J. T. Letcher.*

74. Letcher's half guinea blowpipe cabinet in a stained box.
1880. *Exhibited by T. H. and J. T. Letcher.*

75. Blowpipe cabinet. *Price*, 21*s.*
1886. *Exhibited by Townson and Mercer.*

76. Various blowpipe accessories.
1880. *Exhibited by T. H. and J. T. Letcher.*

Blowpipes at 10*s.* 6*d.*, 4*s.* 6*d.*, 2*s.* 6*d.*, and 8*d.* Hammers at 1*s.* 6*d.* and 1*s.* Anvils at 1*s.* and 6*d.* Forceps at 6*s.*, 3*s.* 6*d.*, 2*s.* 6*d.*, 1*s.* 8*d.*, 6*d.*, 3*d.* Lamps at 1*s.*, 1*s.* in tin, 10*d.* Steel mortar at 16*s.* Stoneware charcoal support, 5*d.* Cupel strikers at 6*d.* and 4*d.* Magnet and chisel at 1*d.* each. Pestle and guard ring at 6*d.* Platinum spoons at 1*s.* 6*d.* and 1*s.* Platinum nozzles at 2*s.* and 4*d.*

77. Four indigo prisms. *Each*, 4*s.*
Exhibited respectively by Reynolds and Branson, by G. Mason & Co., by Townson and Mercer, and J. Preston.
1886.

78. Two indigo prisms. *Price*, 5*s. each.*
1889. *Exhibited by W. Hume & Co.*

G.—*Apparatus for determining Specific Gravity.*

79. Pisani's apparatus for determining specific gravity by displacement.
Lent by the Geological Laboratory, Royal College of
1887. *Science.*

This is adapted for use with small quantities of the substance, or with its powder. It consists of a pair of scales, whose pans are of horn, and weights, together with a specific gravity flask. This is a strong bulb, with a closely fitting stopper in the form of a spout, from the top of which ascends a long graduated tube of narrow bore. By weighing the bulb and water first, then the bulb and water with the substance placed in it, and finally the same with so much water let out as brings it to its former level, all the data for the determination of the specific gravity are obtained.

80. Mohr's apparatus for determining specific gravity by displacement.
Lent by the Geological Laboratory, Royal College of
1887. *Science.*

This is adapted for very large specimens. It consists of an inverted bell jar with stop-cock at base, supported on a wooden

tripod, and a graduated tube below. The mass having been weighed in air, it is placed in the jar with the water up to a certain level; by the insertion of the mass the level of the water is raised, and the quantity that must be let out to bring it to its former level can be passed through the stop-cock into the graduated tube. Hence the bulk, and therefrom the weight of water displaced, is determined.

81. Nicholson's areometer. Constructed to carry 1·17 grammes.
E. 52.—1889.

Consists of a large glass cylinder, with floating areometer. This is now supported on a wooden disc, but in use the cylinder is filled with water, and the areometer is placed in it. The latter is composed of a scale pan at the top, with brass cylinder below, and about 1 inch below that a hollow cone. This serves first to determine the weight of water displaced by any moderate sized substance which, when placed in the upper scale pan, depresses the cylinder to a given position, but when placed in the lower scale, does not depress it so much, and weights have to be added to the top scale pan, to counterbalance the water displaced. The weight in air may be determined by the same apparatus by observing the depression caused by placing the substance in the upper scale pan, and producing an equal depression by weights placed there instead.

82. Nicholson's areometer, improved form.
E. 54.—1889.

This is very similar to No. 81, but a perforated plate movable about a horizontal axis takes the place of the hollow cone for supporting the substance when being weighed in water.

83. Jolly's spring-balance.
E. 51.—1889. *Made by Berberich, Munich.*

This consists of an upright square hollow beam, on a tripod stand, with levelling screws, with a mirror in front. In front of the mirror is supported a long delicate wire spring, which is movable by means of a rod sliding within the beam, and clamped behind. This carries at the base two scales, one below the other, and also a bright bead. Below it stands a platform, which may be raised or lowered, and on which is placed a tumbler full of water. The principle of action is essentially the same as that of Nicholson's areometer; *i.e.*, the weighing of the substance is performed by making it and the equivalent weights have the same effect on the position of the scales, only this is determined, not by their position in relation to the surface of the water, but by the lengthening of the springs, when the substance or weights are placed in the

upper or lower scale, the latter of which is beneath the water in the tumbler. The coincidence of position of the scales, when the substance or the weight is in them is determined by the coincidence in position of the reflected image of the bead in the two cases. It is only adapted for such small specimens as can be placed on the scales and do not unduly strain the springs.

84. Walker's specific-gravity balance. Later form.
E. 48.—1889. *Made by G. Lowdon.*

This is constructed on the principle of the steelyard, and is suitable to solid objects of moderate size. The steelyard is supported on a brass upright, on which it rests by means of a knife-edge; the long arm is graduated. The shorter arm supports the knife-edge of a suspended carrier, on which may be placed one or more short cylindrical brass weights; by this means the range of weighing is greatly increased. The longer arm supports by means of a thread the object to be weighed, which may thus be shifted along it to the position of equilibrium, which gives the weight by a suitable reading of the graduation, whether the object be suspended in air or in a tumbler of water placed below the beam. Too great oscillation of the beam is prevented by a limiting slot in an upright, in which the end of the beam works.

85. Walker's specific-gravity balance. Earliest form.
1887. *Lent by Prof. Judd, F.R.S.*

In this the head of a geological hammer takes the place of the definite brass weights, and the short arm is not graduated; all the pieces are of steel

86. Attwood's specific-gravity balance. Made by Casella.
Lent by the Geological Laboratory, Royal College of
1887. *Science.*

This is also on the steelyard principle, but may be suspended from any convenient support, such as the ring of a retort stand. The steelyard is balanced on a knife-edge working within a suspended ring, and carries a long vertical index, which moves over a fixed graduated arc below, as in an ordinary balance, to indicate when the steelyard is horizontal. The specimen to be weighed is hung on the longer arm, quite close to the point of support, either by a hook or in a copper scale pan, suspended to the hook, which has also a hook below, from which the specimen is suspended when weighed in water contained in a tumbler placed below. The weighing is effected by two sliders; that on the short arm is a heavy one, and its bevelled edge is placed on one or other of the graduations which rise by ounce intervals from

0 to 2 lbs., the larger values being remote from the point of support; that on the longer arm is a light one, and reads from 0 to 48 parts of an ounce, the larger values being nearest the point of support. The substance to be weighed thus balances the larger rider by the aid of the smaller one, and if with the latter at 0 it more than balances the larger when this is placed at the figure representing the next lower ounce to its weight, it will exactly balance it, as the leverage of the small one is reduced by moving it to a higher graduation towards the point of support. The readings of the two riders then give the weight.

87. Parish's specific-gravity balance.

Lent by the Geological Laboratory, Royal College of Science.

1887.

This is very much on the same principle as Attwood's, but is adapted for small specimens only. It works on a knife-edge, and carries a pointer and graduated arc. The object to be weighed is suspended in the middle of the shorter arm by a fixed hook, which carries two scale pans, one below the other, for weighing in water in a beaker. The long arm supports a scale pan hanging from a rider, and is graduated. There is also a small rider on the same side as the point of suspension of the substance to be weighed. The weighing takes place in the same way as in Attwood's, but owing to the difference of weights which may be placed on the scale pan of the long arm, the range of weighing is proportionally greater, or, in other words, the determination is more accurate for small objects. The too great oscillation of the beam is prevented by its working in a limiting slot, in a support at the remote end.

88. Cohen's balance for determining the specific-gravity of heavy liquids, used for the isolation of minerals in rocks. Made by G. Westphal, Celle.

Lent by the Geological Laboratory, Royal College of Science.

1891.

This is a small balance constructed of brass, with levelling plate, and a draw tube, to allow of adjustment for height. The weighing is effected, as in the steel-yard, by the shifting of a weight along the graduated beam of the balance. The instrument is supplied with glass tube for the liquid, and a float with thermometer, attached to the end of the beam for suspension in the substance under examination. A set of riders allows of the measurement of specific gravities of liquids lighter and heavier than water. With these, results can be obtained perfectly correct to three places of decimals.

89. Mohr's specific-gravity balance.
E. 43.—1889.

This form of instrument is in many respects similar to No. 88, and is furnished with tube, riders, and thermometer to adapt it for use in the same way.

The equal length of the two arms of the lever allows of its serving also as an ordinary balance; while it is fitted for use in the measurement of the specific gravities of solids.

It is made of brass, and set on a mahogany stand, having a drawer to contain it when not in use.

A cord passing over two pulleys attached to an upright, allows of the balance being raised or lowered.

H.—*Clinometers, &c. Instruments used in Geological Surveying.*

90. Portable boring apparatus used in the geological survey of Belgium. Invented by E. Van den Broeck and A. Rutot; made by J. Didion, Brussels.
E. 55.—1889.

A full description of the instrument, and of the work done by it, is contained in the "Bulletin de la Société Belge de Géologie, de Paléontologie et d'Hydrologie," Vol. II. 1888. A copy of an extract is shown with the apparatus.

91. Thermometers employed in determining underground temperature by the British Association Committee, Secretary, Prof. J. D. Everett, F.R.S.

(*a.*) Negretti's inverted maximum thermometer with outer glass case to protect it from pressure.

(*b.*) Phillips' maximum thermometer with sealed glass case containing spirits. Designed by Sir W. Thomson; made by Casella.

(*c.*) Stapff's and Everett's slow action thermometer. Made by Negretti and Zambra.

Each of these instruments is supplied with a copper tube to contain it when in use.

E. 44, 46, and 47.—1889.

92. Abney's combined level and clinometer.
1887. *Lent by the Geological Laboratory, Royal College of Science.*

This consists of a long rectangular hollow box, with a pin-hole at one end, and an aperture at the other, so that the base of the instrument may be directed accurately in a given direction

The clinometer consists of a graduated semicircle, the radius corresponding to 0° being parallel in the line of vision. In the centre of the circle is an axis with a milled head, at one end of which is a transverse spirit level, and at the other a radius ending in a vernier, which passes over the graduation of the circle, and is parallel to the base of the spirit level. Thus the angle read off is the angle of dip of the line of vision. At the other end is fixed a compass.

93. Two clinometers, one in mahogany, and the other in boxwood.

1887. *Lent by the Geological Laboratory, Royal College of Science.*

The latter folds like a foot rule, and has a hanging brass pendulum, and graduated semicircle within. The outside is engraved with a table, by means of which the amount of fall for any given dip can be calculated.

94. Three clinometers and four compasses. Prices of clinometers: 10*s.*, 15*s.*, 20*s.*; of compasses, 2*s.* 6*d.*, 7*s.* 6*d.*, 8*s.*, and 20*s.*

1880. *Exhibited by T. H. and J. T. Letcher & Co.*

One of the latter has a brass pendant.

III. Geological Models illustrating Volcanic Action.

95. Model to illustrate the formation of volcanic cones when the ejected materials are of a fragmentary character.

1885. *Designed by C. J. Woodward, Birmingham and Midland Institute.*

This consists of a large square table which is perforated in the centre, and below is fixed a vertical tube, connected at the farther end with an elastic tube leading to a pair of bellows. This is worked by a handle, and sends a continuous vertical blast of air up from the centre of the table. Into the side of the tube near its point of emergence in the table is fixed another horizontal tube, filled with sawdust which is supplied from an open box at the side of the table from which the tube leads, and is continuously pushed forward by means of an endless screw, which is turned by a handle at the end. In this way a vertical shower of sawdust is ejected from the pipe, after the manner in which fragmentary material is ejected from the neck of a volcano. The manner in which the material collects round the vent is thus demonstrated, and by continuing the process with variously coloured sawdusts,

a cone with central crater showing the peculiarities of a volcanic ash cone, is gradually built up. The internal structure of such a cone is here demonstrated by fixing two vertical sheets of glass in a radial direction before commencing operations, and at the end removing all the sawdust which lies between them. In this way the inward slope of the deposit within the crater and the outward slope on the flanks of the cone is fully demonstrated. The proportionate height of the cone depends on the angle of rest of volcanic fragments in one case and of sawdust in the other, but these are not very different, hence the natural slope of such cones is fairly well shown.

For a full explanation of the structure of such cones as illustrated by such a model, *see* Judd's "Volcanoes."

96. Three models illustrating massive eruptions, by Professor E. Reyer of Gratz.

Lent by the Geological Laboratory, Royal College of Science.

1887.

These are produced by squeezing masses of plaster through a vertical hole in the same way as that in which lava is forced up through the neck of a volcano. The form it assumes is dependent on its fluidity, and thus two of these models, made of more fluid material, are flatter than the third, but in all cases the slopes, except immediately over the aperture, are low. Each of these models is cut through the middle to show the internal structure, consisting of a more or less flattened circle passing through the opening of the vent. The different coloured plasters, red and white, show the effect of a subsequent eruption of lava at the same spot.

For full explanation, *see* Judd's "Volcanoes."

97. Raised model of Mount Vesuvius, geologically coloured after Dufreynoy.

E. 141.—1874. *Prepared by J. B. Jordan.*

This is on a horizontal scale of 1 inch to the mile, and stands in an oak frame 1 ft. 8 in. by 1 ft. 4 in. The various minor craters on the slopes are indicated by colour, and the rest is coloured geologically according as it is superficially composed of: —1. Leucitic lavas; 2. Modern lavas; 3. Trachyte; 4. Pumiceous Tufa; 5. Tufa of Pompeii.

IV. Seismographic Apparatus.

98. The Gray-Milne seismograph.

E. 60.—1885. *Made by Jas. White.*

This instrument is designed to record the motion of a point on the earth's surface during an earthquake. Three rectangular components of the motion are written by means of fine glass

siphons on a band of paper, which is kept moving uniformly by a train of clockwork. The siphon which records the vertical component is actuated by a mass supported on the free end of a horizontal lever, which is held in position by a knife-edge and two flat springs bent through a large angle, so as to give the lever a long period of free oscillation. The period is still further increased by means of a small flat spring fixed to the framework below the knife-edge and attached to the lever in such a way as to give the requisite amount of negative stability. The siphons which record the horizontal components are actuated by conical pendulums, so arranged as to have long periods of oscillatory motion.

The time of occurrence and the period of oscillation of the earth are obtained from the position of the record on, and the rate of motion of, the paper-ribbon. These are checked by a separate timepiece, which closes an electric circuit and makes a mark on the paper-ribbon every 10 minutes and a distinguishing mark every hour. These marks, besides giving the rate of motion of the ribbon and the time at which any part passed the driving drum, furnish a datum-line from which the position of the siphon-records may be measured; and thus any change of position of the bobs of the pendulums, occasioned say by a change of level, can be observed. The conical pendulums can be so adjusted as to be extremely sensitive to change of level, and hence the instrument may be used to record slow pulsations of the ground.

The instrument here exhibited is suited for motions of small amplitude.

99. Horizontal pendulum seismograph, with vertical motion seismograph, designed by Prof. J. A. Ewing.

Made by the Cambridge Scientific Instrument Company.

E. 142.—1888.

This instrument consists of two parts, both of which make records on the same revolving sheet of glass. It is only adapted for small motions which require to be magnified in the record. The principle of the instrument is to provide three pendulums which, while the earth is still, are perfectly free to move, each in one direction, such directions being mutually at right angles; and conversely, if the earth moves in any of those directions, they will not partake of the motion, but be relatively displaced. The two horizontal motions are provided for by two vertical bars contained within cylinders, which are set on a tripod with levelling screws. These bars are pivotted at the base by sharp steel points resting in cone-shaped cups; but at the top their points rest in V-shaped grooves, whose directions in the two pendulums are at right angles. In this way motion in one direction only can be recorded by each. The pendulums are furnished with an adjustment by which they are put in nearly neutral equilibrium and stand at right angles to each other. The motion is multi-

plied and recorded by two pointers projecting from the pendulums, and so set that in their oscillation their ends move with exceedingly little friction on the surface of a circular glass plate, which at the time of the earthquake is made to rotate, and they thus trace a pair of magnified records of the earth's horizontal motion in two components, side by side, on the surface of the smoked glass plate, which may then be varnished and used as a negative for taking photographic copies. The vertical component is recorded on the same revolving glass by a pendulum standing on the opposite side. In this there is a massive bar pivotted on a horizontal line, about which it oscillates freely in a vertical direction. The bar is held up by a pair of long spiral springs, and by adjusting the point at which the pull of the springs is applied to the bar, so that it may be below a horizontal plane through the fulcrum, the equilibrium of the bar is made as nearly neutral as is desirable. The bar is pivotted and the pull of the springs applied by hard steel points working in hard steel centres. A light steel bar is fixed vertically to the edge of the pendulum so as to multiply the motion, and carries at its base a horizontal index, so jointed that a vertical motion of the rod is converted into a horizontal motion of the index in a direction radial to the circumference of the smoked plate. Another piece of apparatus is for setting the glass plate in motion so soon as an earthquake commences. It consists of clockwork which, when in action, drives a small friction roller over the surface of the glass plate near its edge, thereby giving it a uniform speed of rotation. The speed of the clockwork is controlled by a balanced centrifugal governor, furnished with vanes which dip into a vessel containing castor oil. The clock is started at the commencement of the earthquake by means of an electro-magnetic detent, which acts whenever an electric circuit is closed by the small seismoscope which stands on the other side. This seismoscope consists of a metal disc, with a small cavity in the centre, contained within an iron cylindrical box, to the top of which it is suspended by three fine wires. From the cavity in the disc a pin passes through a hole in a platinum plate attached to the brass upright of the seismoscope. The slightest disturbance will cause a movement of the disc and consequently of the pin, which will close an electric circuit by contact with the platinum plate. This happens during the preliminary tremors of the earthquake and causes the recording plate to begin revolving before the principal motions are felt. The plate is supported in such a way as to allow it to be removed and replaced without disturbing the rest of the apparatus. Two spare plates are supplied with the seismograph. From the known rate of rotation of the plate, together with the undulating lines drawn by the pointers on its surface, whose magnification is also known, the velocity of displacement and rate of acceleration of a point on the earth's surface may be determined, as well as the direction of each displacement. In this instrument the horizontal motions are multiplied by about 4·1 and the vertical by about 2.

100. Duplex pendulum seismograph, designed by Prof. J. A. Ewing.

Made by the Cambridge Scientific Instrument Company.
E. 143.—1888.

This is an instrument for registering on a fixed plate of smoked glass, with suitable magnification, the whole horizontal motion of the ground. It consists of a vertical case, supported on three levelling screws. On the centre of the base stands an inverted pendulum pivotted in a hard steel cup. The bob of the pendulum is a massive disc. This, though free to move about the base in all directions, is kept vertical, and in nearly neutral equilibrium, by being geared by a ball and socket joint to another somewhat larger massive disc which hangs by three parallel wires from the top of the box. Any horizontal motion of the base is thus communicated to the upper disc. The motion of this disc is recorded by means of a vertical rod which is supported by a gimbal joint fixed on a side bracket, which acts as the fulcrum of a lever; the lower and shorter end of the rod works in the disc by a ball and socket joint, while the upper and longer end carries a horizontal pointer at its extremity, which traces a multiplied record of the motion on a fixed horizontal plate projecting from the case. The degree of stability of the combination is adjusted by raising or lowering the upper disc.

101. Model showing the motion of an earth particle during the earthquake of January 15, 1887.

By Prof. S. Sekiya, Imperial University, Tokio, Japan.
E. 11.—1889.

This consists of a length of red coloured wire twisted about, and divided into three parts. The course taken by the wire represents the path pursued by an earth particle during the above earthquake as determined by the records of horizontal and vertical seismographs. The actual motion of the ground, both horizontal and vertical, is magnified 50 times. The model is made in three parts for convenience, and on it are placed consecutive numbers, from 1 to 72, to indicate the position of the particle at the end of the corresponding second.

For a description of this model and its mode of construction, *see* Journal of the College of Science, Imperial University of Japan, Vol. I.

102. Seismic apparatus to give the time and direction of an earthquake shock.

Made by Brassart Bros., Central Meteorological Office,
E. 10 to 12.—1884. *Rome.*

This consists of an oblong stand with levelling screws. On one end stands a ball on the top of a rod lightly balanced, and standing within a hollow octagon marked with compass points

at the angles. If an earthquake take place this ball and rod fall into one of the eight angles, and so mark the general direction of the motion. At the other end is a pendulum with a brass bob, suspended by wire from a brass support, with its point within a little copper bowl which is used to record any vertical movement of the earth. In the centre is a clock whose pendulum is held by a detent, connected with a pair of electro-magnets, until freed by the passage of an electric current. The circuit is closed and the pendulum at liberty to swing as soon as any movement causes either the wire pendulum or the ball and rod to come in contact with the metal near them. Thus the time of the earthquake is recorded by the starting of the clock. A Leclanché battery and an electric bell to be placed in circuit to call attention to the earthquake are provided with the instrument.

103. Seismochronograph, or apparatus for determining the exact time of an earthquake.

Designed by Prof. von Lasaulx, Royal University,
E. 236.—1877. *Breslau.*

This is similar in principle to the last, but is only part of the whole. It consists of a plate in the centre of which stands a rod working in a hollow vertical cylinder, on the top of which is placed a ball. If by an earthquake the ball be displaced it falls into one of the surrounding cups, the particular one showing the direction of the shock, and at the same time the rod rises and sets loose a wire spring, which causes a neighbouring clock to stop, thus indicating the time of the shock.

104. Photographs and drawings of seismic apparatus used at the Vesuvian and Meteorological Observatory, Naples.

1877. *Given by Prof. Luigi Palmieri.*

1. Portable seismograph by Palmieri, with a printed description.

2. Stationary seismograph made by order of the Hydrographic Department of the English Admiralty, by Prof. Palmieri.

3. Stationary seismograph made for the Vesuvian Observatory.

105. Photograph of an early seismograph. By Niccolo Cacciatore.

1877. *Given by the Royal Observatory of Palermo.*

A circular receiver perforated on the side by eight holes, placed in the direction of the four cardinal points and of the intermediate points. This is placed on a perfectly horizontal plane, and filled with mercury up to the level of the holes, which will therefore spill by running through them on the least oscillation, and in the direction of the oscillation. A

corresponding number of small cups is placed below the holes to receive the spilt mercury which may afterwards be replaced. The amount of mercury in the cups gives an indication of the direction and roughly of the force of the earthquake shock.

V. Sets of Minerals, Rocks, Fossils and Microscopic Preparations for Teaching Purposes.

106. A cabinet containing geological specimens and apparatus. Recommended by Prof. Judd for the use of science teachers.
E. 10.—1883.

A large box with handles and lid, with four trays fitting into it, and containing also geological hammers of two sizes, magnifying glasses of three powers, and a clinometer.

The first two trays contain 25 wooden compartments, each 3½ in. by 4½ in. The first contains the following igneous rocks:

1. Granite, High Downs, Crowan, Cornwall.
2. Granite, Aberdeen.
3. Granite, Shap, Westmoreland.
4. Quartz felsite, Drem, Crowan, Cornwall.
5. Granite (China stone), S. Austell.
6. Rhyolite, Bartos, Hungary.
7. Pitchstone, Corriegills, Isle of Arran.
8. Obsidian, Lipari Isles.
9. Pumice, Lipari Isles.
10. Rhyolite tuff, Glashütte, Schemnitz, Hungary.
11. Syenite, Dresden, Saxony.
12. Elœolite Syenite, Brevig, Norway.
13. Diorite, Freiberg, Saxony.
14. Trachyte, Drachenfels, Rhine.
15. Hornblende Andesite, Stenzelberg, Rhine.
16. Hornblende Porphyrite, Potschappel, near Dresden, Saxony.
17. Claystone, Braid Hills, Pentlands.
18. Phonolite, Aussig, Bohemia.
19. Gabbro, Penig, Saxony.
20. Basalt, Giant's Causeway, Ireland.
21. Basalt, Magospart, Hungary.
22. Melaphyre (amygdaloidal), Heimbach, Nahe.
23. Palagonite tuff, Limburg, Nassau.
24. Serpentine, Lizard, Cornwall.
25. Greisen, Zinnwald, Bohemia.

The second contains the following stratified rocks:—

26. Pipe clay, Corfe Castle, Purbeck, Dorset.
27. Coal shale, Water of Leith, Edinburgh.

28. Clay slate, Bangor, North Wales.
29. Spotted slate, Wechselberg, Saxony.
30. Chiastolite slate, Gefries, Bavaria.
31. Mica slate, Perthshire, Scotland.
32. Mica slate with garnets, Perthshire, Scotland.
33. Hornblende schist, Lizard, Cornwall.
34. Talc schist, Zermatt.
35. Chlorite schist, Zoptau, Moravia.
36. Grey gneiss, Dresden, Saxony.
37. Red gneiss, Bieberstein, Freiberg, Saxony.
38. Conglomerate, St. Alban's, Herts.
39. Millstone grit, Hassop, Derbyshire.
40. Red sandstone, Annan, Dumfries.
41. Quartzite, Hartshill, Warwickshire.
42. Chalk, Kent.
43. Oolitic limestone, near Bath.
44. Dolomitic limestone, Sala, Sweden.
45. Limestone, Carrara.
46. Peat, Banff, Scotland.
47. Brown coal, Bohemia.
48. Common coal, Newcastle.
49. Cannel coal, Wigan.
50. Anthracite, South Wales.

The divisions in the other two trays are for the most part 3 in. by 3 in., and they contain the following minerals and fossils:—

Minerals.

51. Rock crystal, St. Gothard.
52. Massive quartz, Cornwall.
53. Orthoclase, Ytterby, Sweden.
54. Oligoclase, Ytterby, Sweden.
55. Labradorite, Labrador.
56. Leucite, Vesuvius.
57. Nepheline (elæolite), Brevig, Norway.
58. Hornblende, Krageroe, Norway.
59. Augite, Schima, Bohemia.
60. Muscovite, Pennsylvania.
61. Biotite, Renfrew, Canada.
62. Olivine, Eifel, Germany.
63. Garnet, Tyrol.
64. Kaolin, St. Austell, Cornwall.
65. Calcite, Iceland.
66. Gypsum (selenite), Oxford.
67. Magnetite, Arkansas, and crystal from Tyrol.
68. Hæmatite, Cumberland.
69. Pyrite, Cumberland.
70. Rock salt, Cheshire.
70A. Rock salt (white), Worcester.

Fossils.

71. Diplograptus pristis, Moffat, Dumfries.
72. Lingulella Davisii, Portmadoc.
73. Calymene Blumenbachii, Dudley.
74. Taxocrinus tuberculatus, Wenlock, Dudley.
75. Atrypa reticularis, Dudley.
76. Pentamerus Knightii, Aymestry
77. Productus semireticulatus, Carb. Limestone.
78. Spirifer, Carb. Limestone.
79. Goniatites retrorsus, Budesheim, Eifel.
80. Orthoceras, Carb. Limestone, Derbyshire.
81. Lithostrotion basaltiformis, Carb. Limestone.
82. Zaphrentis, Carb. Limestone.
83. Aviculo-pecten papyraceus, Carboniferous.
84. Fenestella, Carb. Limestone.
85. Euomphalus, Carb. Limestone.
86. Pecopteris in nodule, Carboniferous.
87. Sigillaria, Carboniferous.
88. Lepidodendron, Carboniferous.
89. Calamites, Carboniferous.
90. Trigonocarpon, Carboniferous.

(4th Tray.)

91. Gryphæa incurva, Lias.
92. Ammonites margaritatus, Lias.
93. Ammonites bifrons, Lias.
94. Terebratula punctata, Lias.
95. Rhynchonella tetrahedra, Lias.
96. Ostrea Marshii, Inf. Oolite.
97. Apiocrinus rotundus, Bradford clay.
98. Echinobrissus scutatus, Coralline Oolite.
99. Thecosmilia annularis, Coralline Oolite.
100. Gryphæa dilatata, Oxford clay.
101. Belemnites Puzosianus, Oxford clay.
102. Ostrea deltoidea, Kimmeridge clay.
103. Trigonia gibbosa with cast, Portland.
104. Purbeck limestone with Paludina, Swanage.
105. Cinder bed, Purbeck.
106. Ammonites lautus, Gault, Folkestone.
107. Belemnites minimus, Gault, Folkestone.
108. Inoceramus, Chalk, Kent.
109. Micraster coranguinum, Chalk, Kent.
110. Belemnitella, Chalk, Dover.
111. Nipadites, London clay, Sheppey.
112. Pectunculus terebratularis, Woolwich beds, Kent.
113. Cerithium funatum, Woolwich beds, Kent.
114. Cyrena cuneiformis, Woolwich beds, Kent.
115. Cardita planicosta, Bracklesham beds, Bracklesham.
116. Nummulites lævigatus, Bracklesham beds, Bracklesham.

117. Turritella imbricataria, Barton clay, Barton.
118. Voluta luctatrix, Barton clay, Barton.
119. Crassatella sulcata, Barton clay, Barton.
120. Cerithium concavum, Headon beds, Isle of Wight.
121. Cytherea incrassata, Headon beds, Isle of Wight.
122. Fusus labiatus, Headon beds, Isle of Wight.
123. Limnæa, in Headon marl, Isle of Wight.
124. Planorbis, in Headon marl, Isle of Wight.
125. Paludina lenta, Headon beds, Isle of Wight.
126. Cerithium plicatum, Hempstead beds, Isle of Wight.
127. Fascicularia aurantium, Coralline Crag, Suffolk.
128. Fusus antiquus var. contrarius, Red Crag, Suffolk.
129. Lamna elegans, Red Crag, Suffolk.
130. Glacially striated stone, Finchley.

107. Illustrations of British geology and palæontology. Prepared for the Department of Science and Art, by James R. Gregory.
E. 88.—1869.

A series of fossils and other specimens affixed to a MS. table of strata on cardboard and mounted in four glazed frames, 24 in. by 33 in. to stand against the wall, designed to show the order of succession of the various stratified rocks, their principal fossils, localities, mineral characters, uses in the arts, manufactures, &c.

108. Specimens of British rocks (50). In a cabinet. *Price* 10*s.* 6*d.*
1875. *Exhibited by J. R. Gregory.*

Consists of one tray with cover, filled with turned-up card trays, 1½ in. by 2 in. Small irregular fragments. Each carries a number to which a label corresponds.

109. Fifty minerals in a cabinet. *Price* 10*s.* 6*d.*
1875. *Exhibited by J. R. Gregory.*

One tray with cover, filled with turned-up card-trays, each 1½ in. by 2 in. Small fragments, mostly of massive minerals. Each carries a number to which a label corresponds.

110. One hundred minerals in a cabinet. *Price*, 1*l.* 1*s.*
1875. *Exhibited by J. R. Gregory.*

Has two trays, each fitted with turned-up card-trays, each 1½ in. by 2 in. Small fragments, mostly of massive minerals. Each carries a number to which a label corresponds.

111. Two hundred minerals in a cabinet. *Price* 2*l.* 2*s.*
1875. *Exhibited by J. R. Gregory.*

Has four trays, each fitted with turned-up card-trays, each 1½ in. by 2 in. Small fragments, mostly of massive minerals, some crystals. Each carries a number to which a label corresponds.

112. Specimens to illustrate Prof. Geikie's "Primer of Geology." *Price* 10*s.* 6*d.*
1875. *Exhibited by J. R. Gregory.*

One tray with cover containing turned-up card-trays, with 22 specimens, on the average about 2 in. square, numbered according to the figures they illustrate.

113. Twenty-five fragments of minerals for blowpipe experiments. *Price* 2*s.* 6*d.*
1875. *Exhibited by J. R. Gregory.*

In pill-boxes, contained in a larger cardboard box, on the outside of which is a list of the specimens.

114. Fifty fragments of minerals for blowpipe experiments. *Price* 5*s.*
1875. *Exhibited by J. R. Gregory.*

In pill-boxes, contained in a larger cardboard box, on the outside of which is a list of the specimens.

115. Moh's scale of mineral hardness. *Price* 6*s.*
1875. *Exhibited by J. R. Gregory.*

Ten small white trays containing the minerals and a file, enclosed in a green cloth covered box.

116. Von Kobell's scale of fusibility. *Price* 3*s.*
1875. *Exhibited by J. R. Gregory.*

A wooden box in six compartments, each with a mineral; a descriptive label on the lid.

117. One hundred British rocks. *Price* 30*s.*
1877. *Exhibited by Bryce M. Wright.*

Arranged in five mahogany trays in a mahogany cabinet. Each tray contains 20 white card trays, 2 in. by 2½ in. Each specimen carries a number to which a label corresponds. Of the 100 specimens 65 belong to the stratigraphical series, 31 are igneous, and 4 are schists.

118. One hundred minerals arranged according to Phillip's "Mineralogy." *Price* 3*l.*
1877. *Exhibited by Bryce M. Wright.*

Arranged in four mahogany trays contained in a mahogany box. Each tray has 25 white card trays, each 2½ in. by 3 in. Many of the specimens are crystalline. Each carries a number to which a label corresponds.

With these are shown several miscellaneous specimens.

119. One hundred British fossils stratigraphically arranged. *Price* 3*l.*
1877. *Exhibited by Bryce M. Wright.*

Arranged in five stained wood trays in a mahogany cabinet. Each wooden tray has 20 white card trays, each 2 in. by $2\frac{1}{2}$ in. Each specimen carries a number to which a label corresponds.

120. Collection of fossils stratigraphically arranged, contained in 60 cardboard boxes. These fit in two trays of a stained deal box. *Price* 17*s.* 6*d.*
1889. *Exhibited by F. H. Butler.*

121. Collection of rocks and rock forming minerals, 65 specimens, contained in cardboard boxes. Arranged in two trays to fit in a stained deal box. *Price* 17*s.* 6*d.*
1889. *Exhibited by F. H. Butler.*

122. Collection of minerals, rocks, and fossils. *Price* 5*l.*
1879. *Exhibited by S. Henson.*

In six wooden trays. Each tray contains 50 blue card trays (or half trays), each 2 in. by $2\frac{1}{2}$ in. Nearly five trays out of the six are occupied by minerals (249 specimens), the remainder are fossils (56) and rocks (11), numbering in all 316. Each specimen bears a number corresponding to the list in a framed MS. catalogue.

123. Special sets of minerals.
1879. *Exhibited by S. Henson.*

(1.) Specimens in boxes, showing the scale of hardness (2 sets). *Prices* 2*s.* 6*d.* *and* 6*s.* 6*d.*

(2.) Specimens in boxes, showing the scale of fusibility (2 sets). *Prices* 2*s.* *and* 3*s.*

(3.) Examples of selenite, emery, cerite, euxenite, thorite, orangite, strontianite, and cinnabar, in glazed cardboard boxes.

124. Students' collections of geological specimens. *Supplied to students only at* 1*s.* 6*d.* *each, or* 9*s.* *the set.*
1889. *Exhibited by Prof. J. F. Blake.*

Consist of six cardboard boxes with hinged lids, covered in black paper. Each box is divided into 12 deep fixed compartments by cardboard partitions, containing in the several boxes (1) typical rock-forming minerals, (2) sedimentary rocks, (3) igneous and crystalline rocks, (4) primary fossils, (5) secondary fossils, (6) tertiary fossils.

125. Elementary collection of rocks, minerals, and fossils. *Price* 10*l.*

1857. *Exhibited by A. Krantz, Bonn.*

Consists of six trays enclosed in a stained deal box. Each tray is divided into forty-eight 3 in. square compartments by wooden partitions. Each specimen bears a number with a label corresponding. Three of the trays contain minerals, mostly massive. Two trays contain a stratigraphical series of rocks, together with the fossils belonging to them, which are not British types; and one tray contains volcanic and igneous rocks.

126. Elementary collection of rocks, minerals, and fossils. *Price* 5*l.*

1857. *Exhibited by A. Krantz, Bonn.*

Consists of five trays in a deal box. Each tray is divided into 60 2½ in. square compartments by wooden partitions. Each specimen bears a number with a label corresponding. Of the specimens 153 are minerals, some being crystalline. 93 are rocks stratigraphically arranged with the fossils belonging to them, which are not British types; and 54 are volcanic and igneous rocks.

127. Collection of American minerals, &c., arranged for the use of Science Teachers.

1888. *Exhibited by A. E. Foote, M.D., Philadelphia.*

The specimens, of average size, about 4 in. square, have each a number and descriptive label.

The first hundred numbers are consecutive. The remainder appear to be a selection from a larger series.

128. Special collections of minerals and rocks.

1888. *Exhibited by A. E. Foote, M.D., Philadelphia.*

Five small card boxes.

(1.) Divided into 25 compartments, 1 in. square, each with small fragments of minerals forming a "colour series."

(2.) Likewise divided into 25 compartments, with minerals forming a "crystallographic series." *Price* 4*s.*

(3.) Divided into 12 compartments, containing minerals forming the scale of hardness. *Price* 4*s.*

(4.) Divided into six compartments, containing minerals forming the scale of fusibility. *Price* 1*s.*

(5.) Collection of non-metallic minerals (25 specimens). *Price* 4*s.*

129. Collection of fossils. *Price* 21*s.*

1889. *Exhibited by P. Harris.*

Two wooden trays, fitting in a box. The specimens are contained in turned-up card trays, 1½ in. by 2 in., 100 in all, four being of half size. Each specimen bears a number and a label.

130. Collection of minerals (50 specimens) in two trays contained in a box. Each specimen shown in cardboard tray of 2½ by 2 in. size. *Price* 1*l.* 12*s.* 6*d.*
1891. *Exhibited by Harrington Bros.*

131. Typical collection of rocks. Sedimentary, volcanic, plutonic.
1876. *Exhibited by the late R. Damon.*

These are not enclosed in trays, but are loose. The specimens are partially trimmed to size, the average being about 3 in. by 4 in.

132. Typical collection of Eocene fossils. Comprising 100 species.
1876. *Exhibited by the late R. Damon.*

133. Elementary collections.
1858. *Exhibited by Reynolds & Co.*

(1.) "British minerals." 28 minute fragments gummed to a card printed with names which is fixed in the inside of box, shaped like a small octavo book.

(2.) "Systems of British rocks," 3*s.* 6*d.* 25 minute fragments gummed to a printed card showing five epochs, enclosed in a box shaped like a small octavo book.

(3.) "Characteristic specimens of British rocks," 10*s.* 6*d.* 47 minute fragments arranged as in the last collection, enclosed in a larger octavo book-shaped box.

134. Two hundred rocks and minerals.
E. 71.—1857. *Prepared by Eloffe & Co., Paris.*

Consists of drawers, containing white card trays of various sizes, containing minerals of various kinds, arranged according to M. N. Boubée.

135. One hundred rocks and minerals.
E. 72.—1857. *Prepared by Eloffe & Co., Paris.*

Consists of drawers, containing green card trays, average size about 2 in. by 3 in.

136. Examples of minerals. Prepared by W. Anderberg, of Stockholm, for use in the public schools of Sweden.
E. 28.—1869. *Presented by the Swedish Government.*

Sixty specimens contained in blue paper trays without box. Each tray about 4 in. by 2½ in. 21 are artificial products.

137. General collection of fossils.
E. 50.—1862. *Presented by the Belgian Government.*

Two open trays with 100 fixed compartments, with paper-covered partitions. Small specimens.

138. Collection of minerals and rocks to illustrate lessons in elementary schools.
E. 105.—1862. *Presented by the Belgian Government.*

Consists of two trays, each divided into compartments by green paper partitions 1½ in. square. The minerals are mostly massive; a few of the specimens are rocks.

139. Collection of minerals and rocks to illustrate lessons in elementary schools.
E. 104.—1862. *Presented by the Belgian Government.*

Four cardboard trays in 25 fixed compartments each. The size of compartments is 2½ in. by 2½ in., or 2½ in. by 3 in. More than half of the specimens are rocks.

140. Collections of thin sections of minerals and rocks, and of other microscopical objects, for use in geological teaching.
E. 33.—1891.

Sets of microscopic slides for the use of teachers of Physiography, Geology, and Biology (similar to those used in the Geological Division of the Royal College of Science, London).

Series A.—Six slides illustrating Physiography, in cloth case.

1. Foraminiferal sand.
2. Globigerina-ooze.
3. Radiolarian-ooze.
4. Diatomaceous earth.
5. Volcanic dust.
6. Desert-sand.

Series B.—12 slides illustrating Physiography, in cloth case.

1. Capillary volcanic ash.
2. Volcanic dust.
3. Crystalline sand.
4. Crystalline sand (cleaned) in balsam.
5. Desert-sand (rounded grains).
6. Angular sand.
7. Diatomaceous earth.
8. Marine diatoms.
9. Radiolarians.
10. Foraminiferal sand.
11. Globigerina-ooze.
12. Glauconite-grains.

Series C.—12 slides of typical igneous rocks, cloth case.

1. Granite.
2. Quartz-felsite.
3. Rhyolite.
4. Obsidian.
5. Syenite.
6. Trachyte.
7. Diorite.
8. Andesite.
9. Phonolite.
10. Gabbro.
11. Basalt.
12. Serpentine.

Series D.—12 slides of typical sedimentary and metamorphic rocks, cloth case.

1. Sandstone.
2. Chalk.
3. Oolitic limestone.
4. Crystalline limestone.
5. Clay-slate.
6. Whet-slate.
7. Chiastolite-slate.
8. Gneiss.
9. Mica-schist, with garnets.
10. Hornblende-schist.
11. Chlorite-schist.
12. Quartzite.

Series E.—36 typical rock sections, in polished box.

1. Muscovite-granite.
2. Hornblende-granite.
3. Graphic granite.
4. Luxullianite.
5. Quartz-felsite.
6. Banded rhyolite.
7. Obsidian.
8. Pumice.
9. Pitchstone.
10. Perlitic pitchstone.
11. Spherulitic felsite.
12. Syenite.
13. Trachyte.
14. Hornblende-mica-diorite.
15. Granulitic hypersthene-diorite.
16. Quartz-diorite.
17. Hornblende-Andesite.
18. Augete-Andesite.
19. Porphyrite.
20. Nepheline-phonolite.
21. Nosean-phonolite.
22. Leucite-phonolite.
23. Gabbro.
24. Diabase.
25. Basalt.
26. Ophitic basalt.
27. Leucite-basalt.
28. Picrite.
29. Limestone, with foraminifera.
30. Oolitic limestone.
31. Clay slate.
32. Chiastolite-slate.
33. Mica-schist with garnets.
34. Chlorite-schist.
35. Gneiss.
36. Quartzite.

Boxes of slides, similar to the above, which are prepared by R. Chapman, can be obtained from J. R. Gregory, 88, Charlotte Street, Fitzroy Square, W., at the following prices :—Series A., 6*s.* 6*d.* ; Series B., 12*s.* 6*d.* ; Series C. and D., each, 18*s.* ; Series E., 2*l.* 12*s.* 6*d.*

VI. Plaster Casts of Fossils.

141. Casts of fossils in 11 frames, glazed.
E. 33 to 64.—1888. *Made by B. Stürtz, Bonn.*

The following are the subjects :—

1. Cast, 32 in. by 18 in. *Pentacrinus subangularis.* Miller, from the Lias of Holzmaden. The original in the Philadelphia Academy of Sciences

2. Eight fossils. *Taxocrinus Sturtzii,* Follm., U. Devonian, Bundenbach ; *Godiacrinus Schultzii,* Follm., U. Devonian Gemünden ; *Poteriocrinus Zeæformis,* Follm., U. Devonian Gemün-

den; *Poteriocrinus minutus* (Lophocrinus speciosus), Kulm, sub-carbonif., Herbon; *Ctenacrinus decadactylus*, Römer, U. Devonian Lahnstein; *Eoluidia Decheni*, Stürtz, U. Devonian, Bundenbach; *Bundenbachia Beneckii*, Stürtz (ventral), U. Devonian Bundenbach; *Ophiurella primigenia*, Stürtz (dorsal), U. Devonian Bundenbach.

3. Nine fossils. *Loriolaster mirabilis*, Stürtz (dorsal), U. Devonian Bundenbach; ditto (ventral); *Xenaster margaritatus* (dorsal), Simonovich, U. Devonian Lahnstein, original in Berlin Museum; ditto (ventral); *Xenaster simplex*, Simonovich, U. Devonian Lahnstein, original in Berlin Museum; *Römeraster asperula*, Stürtz (ventral), U. Devonian Bundenbach; ditto (dorsal); *Furcaster palæozoicus*, Stürtz (ventral and dorsal), U. Devonian Bundenbach.

4. Five fossils. *Palastropecten Zitteli*, Stürtz, U. Devonian Bundenbach; *Ophiurella primigenia*, Stürtz (ventral), U. Devonian Bundenbach; *Aspidosoma Tischbernianum*, Römer, U. Devonian Bundenbach; ditto (another); *HelianthasterRhenanus*, Römer (dorsal), U. Devonian Bundenbach.

5. Three fossils. *Asaphus platycephalus*, Stokes, Silurian, New York; *Diplema Dekayi*, Green, Low. Devonian, New York; Chelonia, Eocene, London clay, Sheppey, original in the Berlin Museum.

6. Cast, about 20 in. by 42 in., represents the body of *Gyrodus*. No teeth. The original in the Museum at Lisbon.

7. Cast, about 12 in. by 18 in., represents *Rhamphorhynchus phyllurus* (Marsh). Original in the Yale College Museum.

8. Cast, about 16 in. by 48 in., represents *Ichthyosaurus tenuirostris*, Lias, Holzmaden. Original in Provincial Museum, Hanover.

9. Cast, about 10 in. by 30 in., represents *Aspidorhynchus acutirostris*, Agassiz. Original in the University Museum, Strasburg.

10. Cast, about 18 in. by 36 in., represents *Spathobatis mirabilis*. Original in the University Museum, Strasburg.

11. Cast, about 14 in. by 16 in., represents *Pterodactylus Kochii*. Original in University Museum, Berlin.

VII. Diagrams for Teaching Purposes.

142. Series of 12 drawings illustrating physical geology.

Prepared for the Science and Art Department by J. B. Jukes and G. V. Du Noyer. 1857.

These are framed pictures, 3 ft. 4 in. by 2 ft. 4 in., and illustrate:—1. Columnar structure; 2. Slaty cleavage; 3. Concretions; 4. Elevation and contortion; 5. Faults or dislocations;

6. Coal mining; 7. Igneous veins and dykes; 8. Joints in sandstone; 9. Lamination and stratification; 10. Denudation and unconformity; 11. Vein mining; 12. Volcanoes.

The authors of these drawings were members of the Irish Geological Survey, and their illustrations, with few exceptions, are drawn from actual observations made in the field.

143. Geological diagrams by P. Gervais, on linen and rollers. *Price*, 30*s*. *unmounted*.

1881. *Published by G. Masson, Paris.*

These are drawn on a black ground, and are of uniform size, about 2 ft. 11 in. by 2 ft. 2 in. Ten represent fossils, and two the phenomena of glaciers, volcanoes, springs, &c. See No. 185.

144. Two diagrams by Credner, mounted with rollers, representing the *Stegocephala* of the Rothliegende, viz., *Branchiosaurus amblystomus*, *Pelosaurus laticeps*, and *Melanerpeton pulcherrimum*.

1887. *Published by W. Englemann, Leipzig.*

145. Diagrams of fossils. Prepared by Dr. Karl A. Zittel and Dr. K. Haushofer. Mounted on linen and roller; size 4 ft. 8 in. by 3 ft. 8 in. *Price, mounted, with text*, 30*s*.

1880. *Published by H. Fischer, Cassel.*

There are six diagrams representing invertebrate fossils, viz., 1. Rhizopoda; 2. Sponges; 3, 4. Corals; 5. Mollusca; 6. Restoration of the coal period.

146. Table of British strata. Coloured by J. B. Jordan. Mounted on linen and roller; size 9 ft. 5 in. by 3 ft. 4 in.

1884. *Published by E. Stanford.*

147. Johnston's Illustrations of Natural History.

No. 5. Mineralogy and Palæontology. Prepared by Prof. C. Gilbert Wheeler; size 4 ft. 4 in. by 3 ft. 6 in. Mounted on linen and roller.

1879. *Published by W. and A. K. Johnston.*

148. Plates of British fossils. Nineteen sample plates from the annual volumes of the Palæontographical Society.

1876. *Lent by Rev. Thos. Wiltshire.*

149. Plates illustrating microscopic structure in minerals and rocks. A group of four plates, framed and

glazed. From drawings in lampblack and pencil by Frank Rutley, F.G.S., of H.M. Geological Survey.

1876. *Lent by Frank Rutley, F.G.S.*

They have been published in the Monthly Microscopical Journal. The two upper illustrate structures in obsidian, leucite, and perlite; the two lower illustrate plagioclase and microcline structure.

150. Wall map of the natural history of the Mineral Kingdom, by Dr. G. Seelhorst.

1877. *Given by P. C. Geissler, Nürnberg.*

This consists of six coloured plates, which are mounted on linen so as to form a single sheet. It will fold up and go into a portfolio. The text is printed on both sides of the map. The first four plates represent mineral masses and crystals, and the last two represent fossils. No date is attached.

151. Table of British strata, showing the order of superposition and the comparative thickness of the formations. Size, 4 ft. 5 in. by 2 ft. 4 in. In a frame, glazed. Published by Chapman and Hall.

Given by the late H. W. Bristow, F.R.S.

The strata are represented in three parallel columns, each showing the whole series; the first for the great subdivisions, the second for the smaller subdivisions, and the third for the lithological characters. The proportion assigned to the Palæozoic rocks is about 84 per cent. of the whole; to the secondary rocks about 13 per cent., and to the tertiary about 3 per cent.

VIII. Relief Models.

152. Terminological relievo maps, by Paulini. Size 12 in. by 10 in. Edited by the Imperial Royal Administration of Text Books, Vienna.

E. 173.—1862.

Presented by the Austrian Government.

These are coloured models of alpine and lowland surface features in black wood frames. They are not geological, but indicate the geographical terms applied to the surface.

153. The Island of St. Paul in the Indian Ocean. By Capt. J. Cybule. In morocco case. Size 23 in. by 19 in.

E. 129.—1862.

Presented by the Austrian Government.

This model is in electro-bronze for the land, and blue painted surface for the sea. The depths of the water within the crater

are marked by contours for every 10 ft., and round the island by contours for every 50 ft. Scale about 160 ft. per inch. It is not geologically coloured.

154. Model of Barren Island Volcano, Bay of Bengal, latitude 12° 15′, N.; longitude 93° 50′, E. Scale, 20 inches to the mile. Size, 50 inches square. Designed by V. Ball, M.A., F.R.S.; constructed by Miss W. Spence.
E. 23.—1890.

This model is coloured to show the positions of the older lava, younger lava, alluvium, ash, and pumice.

155. Relief model of the Puy de Dôme group, Auvergne, France. By L. I. Bardin and Commandant Peigné. Scale, $\frac{1}{40000}$.
E. 312.—1877. *Published by C. Delagrave, Paris.*

The model is 32 in. by 20 in., and is executed in white plaster. It is not geologically coloured; nor is it accompanied by names, contours, orientation.

156. Relief model of the Puy de Dôme group, Auvergne, France. Geologically coloured. Size, 32 in. by 20 in. Scale, $\frac{1}{40000}$.
E. 313.—1877. *Published by C. Delagrave, Paris.*

This is the same model as the last, except that the lavas, granites, &c., are coloured, but it is not provided with the names of places or Puys.

157. Terminological relief map by Reyer of Gratz. Size 8 in. by $5\frac{1}{2}$ in. Scale about $6\frac{1}{2}$ inches to the mile $\frac{1}{9600}$.
Lent by the Geological Laboratory, Royal College of
1887. *Science.*

Coloured agriculturally. Green, meadow land. Green dots, forest. Brown, arable land.

158. Geological model of a volcanic district. By Reyer. Size 10 in. by $8\frac{1}{2}$ in. Scale about 5 inches to the mile $\frac{1}{12\,3\,0}$.
Lent by the Geological Laboratory, Royal College of
1887. *Science.*

Shows 10 colours, for light coloured Tuff, darker Tuff, Andesite, Andesite-Trachyte, Plagioclase-Trachyte, Common Trachyte, Quartz-Trachyte, Jurassic, Chalk, and Eocene.

159. Geological model of a volcanic district, by Reyer. Size $7\frac{1}{2}$ in. by $7\frac{1}{2}$ in. Scale $\frac{4}{5}$ in. to the mile.

Lent by the Geological Laboratory, Royal College of 1887. *Science.*

In three colours, two for sedimentary rocks, and one for eruptive. The two sedimentary rocks are in loose pieces, which may be removed so as to show the position of the eruptive rocks below ground.

160. Geological model of the volcanic district of Predazzo, by Reyer. Size $9\frac{1}{2}$ in. by $9\frac{1}{2}$ in. Scale $2\frac{5}{8}$ in. to the mile $\frac{1}{24000}$.

Lent by the Geological Laboratory, Royal College of 1887. *Science.*

Shows 10 colours for Wengener Kalk, Muschel Kalk, Sand and loose stones, Quartz-Porphyry, Monzonite, Syenite, Granite, Dark coloured Porphyry, Elæolite-Porphyry, and Orthoclase-Porphyry.

161. Model showing stratification in rocks.

Under a glass shade. Size 18 in. by 9 in. by 10 in. high.

E. 315.—1877. *Published by C. Delagrave, Paris.*

Model of a quarry showing thin oblique beds in the quarry face, without any conspicuous joints.

162. Set of four models of part of the Jura Mountains chain of Reculet. By L. I. Bardin and Commandant Peigné, scale $\frac{1}{40000}$. Size 2 ft. 8 in. by 1 ft. 8 in., representing an area of 40 square leagues. Under glass shades.

E. 310 and 316 to 318.—1877.

Published by C. Delagrave, Paris.

This set is designed to show the method of preparing geological models by the aid of maps.

The first is constructed by taking a map on which the contour lines are marked at intervals of 10 metres or 33 feet. Sheets of cardboard of uniform thickness are then cut out so that their outline corresponds with the contour lines. A flat surface is then taken, and the cardboards representing the lowest contour, say of 10 metres above the lowest point in the district, are glued on in their proper places. On the surface of these the cardboards representing the next higher contours of 20 metres, are glued and so on, till the highest contoured cardboard has all the lower contours beneath it. The model then shows the contour lines by the edges of the several sheets of cardboard, and the higher parts are raised above the lower

the vertical scale being dependent on the thickness of the sheets of cardboard.

In the second, the edges are smoothed down and the minor known features of the district, which, occupying less than 33 ft., may escape the contour lines, such as rivers, roads, &c., are inserted by carving. From this any number of plaster casts may be taken. It represents the geographical features only. In the third, a geological map is taken, and the outcrops of the various strata are marked by grooves on the surface, whose inclination and course show the stratification. These lines have somewhat the aspect of the edges of the contour lines in the first model, but they are not horizontal. In the fourth and final model, the different strata thus indicated are coloured according to their geological age. Five of these colours are shown, but there is no index of their meaning, nor are the names of places given.

From the second and third of the series any number of casts can be taken, but the fourth has in each case to be coloured by hand.

163. Model in relief of part of the Alps, including Monte Rosa and the Matterhorn. The scale for the vertical and horizontal measurements is the same, viz., $\frac{1}{25000}$, hence there is no exaggeration of the heights. Size 4 ft. 6 in. by 3 ft. 8 in., under glass shade. By X. Imfeld.

E. 6.—1887. *Published by J. Würster & Co., Zurich.*

The bare rocks are coloured in brown, pasture land in light green, trees in dark green, snow fields and glaciers in white, the moraines on the latter by dark lines, the crevasses by cross lines. No names are affixed to any of the features, but the model is accompanied by a book of photographs (*see* under Photographs), which includes a map with all particulars. The deep valley shown on the north side is the valley of the Visp, in which Zermatt is situated. The range on the eastern side has the Dôm at the northern end, the Rimpfischhorn in the centre, and Monte Rosa at the southern. It gives rise to three large glaciers, one to the east and two to the west. The range running east and west across the head of the valley is the Lyskamm range, culminating in the sharp wedge-shaped Matterhorn, a little to the west of the valley, with the Dent d'Herens behind it. Four glaciers descend from this portion, one into the Zermatt valley, one south and two north. The range on the western side of the valley commences with the Weisshorn on the north ; behind it is the Rothhorn, and nearer the head of the valley is the Dent Blanche. From this two glaciers descend, one with numerous moraines.

164. Model of the Monte Rosa Alps. Size of actual model 3 ft. by 2 ft. Under a glass shade. Scale about $\frac{1}{30000}$; vertical scale very little, if at all, exaggerated.
1865. *Lent by H. Ellis.*

This is a model of the same district as the last on a slightly smaller scale. It shows the valley of the Visp with the Rimpfischhorn on the east and the Rothhorn on the west. Further south Monte Rosa is seen on the east and the Matterhorn on the west, with the several glaciers they give rise to.

165. Relief model of the western Alps and Ligurian Apennines. Size of actual model 4 ft. 6 in. by 3 ft. 11 in. Horizontal scale $\frac{1}{250000}$, or about 4 miles to the inch. Vertical scale $\frac{1}{125000}$, or twice the horizontal. Prepared by Major Claudio Cherubini.
E. 79.—1886. *Published by Roux and Favale, Turin.*

This is coloured according to the elevations. Highlands are of a brown tint, the lowlands are coloured green. The rivers are marked in dark green (lakes in blue), glaciers and snow fields in white. Comprises all the district from Lausanne on the north to Monaco on the south, and from Chambery on the west to Milan on the east. The roads, towns, railways, and political boundaries are also indicated. There is an explanation in Italian indicating the minor ranges included in the map, viz., the western portion of the Rhœtian Alps from Surettahorn to S. Gotthard, with 12 other peaks. The Lepontine Alps from S. Gotthard to Monte Rosa, with 20 other peaks. The Pennine Alps from Monte Rosa to Mont Blanc, with 19 other peaks. The Graian Alps from Mont Blanc to Mont Tabor, with 35 other peaks. The Cottian Alps from Mont Tabor to Enciastraia, with 22 other peaks. The Maritime Alps from Enciastraia to Mont Saccarello, with 19 other peaks. The western Ligurian Apennines from Mont Saccarello to Mont Lavagnola, with 18 other peaks. The eastern Ligurian Apennines from Mont Lavagnola to Mont Ramaceto, with two other peaks. Each peak has a small label attached to it giving its name. The mountains of the Bernese Oberland are also represented and named in the map, but are not referred to in the explanation.

166. Model of Mont Blanc, showing the glaciers. Scale 1 in. to the mile horizontal. Vertical heights not exaggerated. Size, 24 in. by 20 in.
E. 142.—1874. *Modelled by Jas. B. Jordan.*

The cultivated land is represented in green, the bare rocks in grey, the glaciers and snow fields in white. The names of all

the glaciers are marked on the model, as well as the names of the principal towns, valleys, and rivers, but the subordinate peaks of the group are not named.

167. Model of the Val deBagnes and adjacent country, showing the districts devastated by the inundation of 1818. Size, 1 ft. 5 in. by 1 ft. $2\frac{1}{2}$ in.

E. 21.—1891. *Given by Mrs. Stopford.*

The glacier de Gétroy, the lake formed by the interception of the course of the Drance, and other places of interest are indicated by numbers, the index to which is shown with the model.

168. Relief map of Europe, showing the physical features. Size, 4 ft. 10 in. by 4 ft. 6 in. Horizontal scale $\frac{1}{4000000}$, or about 63 miles to the inch; vertical scale $\frac{1}{1000000}$, or four times the horizontal. Under glass shade. Modelled by M. E. Levasseur and Mlle. Kleinhans.

E. 80.—1886. *Published by C. Delagrave, Paris.*

The depths of the sea are marked by contour lines—without any difference of colour—the contour lines corresponding to 100 metres, 500 metres, 1,000 metres, and 2,000 metres. The general colour of the sea is blue. The lakes are shown in a deeper shade of blue, and the "chotts" of Africa by a lighter shade. The land is coloured brown. The higher elevations are coloured in a deep tint, so as to make the relief more visible. Perpetual snow is marked in white, and volcanoes by a red spot. The political boundaries by red lines.

169. Relief map of Europe, geologically coloured. Size, 4 ft. 10 in. by 4 ft. 6 in. Horizontal scale $\frac{1}{4000000}$, or about 63 miles to the inch; vertical scale $\frac{1}{1000000}$, or four times the horizontal. Under glass shade. Modelled by M. E. Levasseur and Mlle. Kleinhans.

E. 78.—1886. *Published by C. Delagrave, Paris.*

The depths of the sea are shown by contour lines, and also by shades of colour, the greatest depths by the lightest shades. The contour lines correspond to 100, 500, 1,000, and 2,000 metres. The rocks are indicated by 11 colours, representing Quaternary deposits, Tertiary, Cretaceous, and Jurassic rocks, Trias and Permian together, transition rocks, *i.e.*, Carboniferous to Cambrian, Primary, meaning gneiss, granite, &c., porphyries, volcanic rocks distinct from the last, and unknown rocks. The geology, therefore, is not of the modern kind, and there are no names of countries, rivers, seas, or other features.

170. Model of Jerusalem, geologically coloured. Size, 23 in. by 23 in., in glazed frame; scale $\frac{1}{10000}$, or about $6\frac{1}{3}$ inches to the mile. Constructed under the direction of Col. Sir H. James, R.E.

E. 3.—1869.

This is constructed from the contoured maps of the Ordnance Survey, the contours representing intervals of 25 ft. There are four geological colours, viz., pink, for pink and white chalk; white, for soft white chalk; brown, for hard siliceous chalk; and blue, for nummulitic limestone.

171. A representation of Columnar Basaltic Rocks. Size, 14 in. by $11\frac{1}{2}$ in., and 6 in. high. Under glass shade.

E. 314.—1877. *Published by C. Delagrave, Paris.*

This model, which is entirely in white, shows a long hill with vertical sides in those parts which are formed by the basaltic columns. Below these parts are the screes of broken basalt, and elsewhere is represented the smoothness of the overgrowing turf.

172. Drawing and model, representing mountain chains.

To show the method of preparing relief models. From the Upper Practical School, Schottenfelde, Vienna.

E. 131.—1862. *Presented by the Austrian Government.*

This consists of a map on one side, and the corresponding model on the other, both mounted in one oak frame, 23 in. by 10 in. The map represents the neighbourhood of the mountain Orteles, but the heights in this are not indicated by contours, but by shading. The relief model is, however, made by placing contour cards one over the other. The surface is not coloured geologically, but according to the agricultural character of the surface, such as rocky, peat, pasture land, &c.

173. Contoured model of the British Isles, including the submarine plateau and surrounding area. Size, 4 ft. by 4 ft. Horizontal scale $\frac{1}{1520000}$, or about 24 miles to the inch; vertical scale $\frac{1}{96000}$, or 8,000 ft. to the inch, being about 16 times the horizontal scale.

E. 190.—1888. *Constructed by Jas. B. Jordan.*

The surface of this model is left unaltered after the fixing of the contour cards, in order that the method of construction may be seen. Since the contours represent intervals of 250 ft. on the land, no surface feature which occupies less than that interval is depicted, and thus the hills all appear flat on the top,

and undulating country is not distinguished from fen-land. The amount of alteration necessary would, however, be very slight—showing the real insignificance of these features on a large scale. The watersheds of the different river systems are well shown by this method. The land is in brown. The depths of the sea are shown by contour lines, having the same interval, or about 42 fathoms, and the surface is coloured deeper in zones of 5,000 ft. It shows well the shallowness of the North Sea, and even the comparative shallowness of the Skagrerack in comparison with the deep Atlantic basin some distance to the west of the British Islands, and only broken by the submarine plateau which culminates in the Island of St. Kilda. Accompanying the model is a small map comprising the same area, which serves as an index of localities.

174. Geological model of the south-east of England, and part of France, including the Weald and the Bas Boulonnais. Founded upon the maps of the Ordnance, Admiralty, and Geological Surveys, by W. Topley, F.G.S., Geological Survey of England and Wales, and James B. Jordan, Mining Record Office. The topography by John Bartholomew, F.R.G.S. Embossed by Henry F. Brion, London. Horizontal scale. 1 in. to the 4 miles. Vertical scale, 1 in. to 2,400 feet, or nearly nine times the horizontal. Size, 34 in. by 18 in.

E. 122.—1880. *Published by E. Stanford.*

This model is constructed in a different manner from that by which most models are made, in which the names, &c. are marked on the modelling material itself. In this case the relief of the country is first modelled on an unmarked surface, and then an ordinary engraved and geologically coloured map, with all the names of places and features that are usual on such maps, is taken and pressed upon the surface when wet, so that without tearing, it fits itself to the various elevations and depressions, and thus partakes of the relief of the underlying model. There is an index of colours, and the map is accompanied by a horizontal section from the English Channel, near Seaford, to the Isle of Sheppey, on the same horizontal scale as the model and vertical scale, one half that of the model. The vertical sides of the model are also utilised to indicate the geological section along the boundary lines of the map.

175. Model of the valley of the Thames, showing the physical features and the geology, by James B. Jordan. Constructed from contours drawn by W. Topley, F.G.S., the geology reduced from the Geological Survey. Horizontal scale, 4 miles to the inch. Vertical scale, 1 inch

to 2,400 feet, or nearly nine times the horizontal. Embossed by Henry F. Brion, London. Size, 37 in. by 21 in.

E. 143.—1874.

This extends from the Isle of Sheppey to Malvern, and covers the same ground as the map given in Phillip's Geology of Oxford and the Valley of the Thames. There are 18 colours used for the geology. The line of watershed between the valley of the Thames, and the surrounding river basins is marked by a red dotted line. The names of the principal hills, rivers and towns are marked, but no roads or railways are inserted.

IX. Geological and Physical Maps.

A.—*Geological. General Maps.*

176. Geological map of the World, by J. Marcou. Varnished and mounted on rollers. Published by J. Würster & Co., Zurich. Constructed by J. M. Ziegler. Size, 72 in. by 50 in., on Mercator's projection.

1876. *Sold by E. Stanford.*

177. Geological map of the British Islands, by Edward Best. Scale, 28 miles to the inch.

1888. *Published by E. Stanford.*

178. Geological map of the British Islands, prepared for the Rivers Pollution Commission, Sixth Report. The Domestic Water-Supply of Great Britain, 1874. Chiefly from the maps of the Geological Survey, under the superintendence of Edward Best. Scale, $\frac{1}{1600000}$, or about 25 miles to the inch. Published by E. Stanford, 1874.

1876. *Lent by E. Best.*

Nearly identical with No. 177, except that it is on a little larger scale.

179. Geological map of the British Isles and adjacent coasts of France, by John Phillips, M.A., F.R.S., Professor of Geology in the University of Oxford. Engraved by J. W. Lowry, F.R.G.S. First issued in 1834. Corrected to 1862. On rollers. Scale, 24 miles to the inch.

Lent by the Society for Promoting Christian Knowledge.

1876.

180. Geological map of England and Wales, with all the railways, according to the most recent researches, by Sir Roderick I. Murchison, K.C.B. Fifth edition, 1864. Price 5*s.*, unmounted. Scale, 25 miles to the inch. In glazed frame. Size, 14 in. by 17 in.
1870. *Published by E. Stanford.*

181. Geological map of England and Wales, by Andrew C. Ramsay, LL.D., F.R.S., Director-General of the Geological Survey of the United Kingdom and of the Museum of Practical Geology. Fourth edition, 1886. Scale, 11 miles to the inch. Has the railways shown, and there are six illustrative geological sections in the margin. Size, 42 in. by 36 in.
1888. *Published by E. Stanford.*

182. Geological map of Scotland, by Sir Roderick I. Murchison, K.C.B., F.R.S., and Archibald Geikie, F.R.S.E., revised up to January 1865. Scale, 25 miles to the inch. In small gilt frame. Has four illustrative geological sections in the margin.
1888. *Published by W. and A. K. Johnston.*

183. A general map of Ireland to accompany the reports of the Railway Commissioners, showing the principal physical features and geological structure of the country. Size, 6 ft. by 5 ft. Scale, about 4 miles to the inch. 1855. It contains six sheets and has eight illustrative geological sections engraved round it.
1876. *Published by Longmans & Co.*

184. Geological map of Ireland. Founded on the maps of the Geological Survey, on that of Sir Richard Griffith, and that of Prof. J. Beete Jukes, by Edw. Hull, M.A., F.R.S., Director of the Geological Survey of Ireland. Varnished and mounted on rollers. Scale, 8 miles to the inch.
1888. *Published by E. Stanford.*

185. Geological map of France with sections, mounted on rollers with a black background.
1881. *Published by G. Masson, Paris.*
Issued with Gervais' diagrams. *See* No. 143.

186. Geological map of the Arctic Regions, by C. E. De Rance, F.G.S. A MS. map 16 in. by 12 in., showing

rocks distinguished by eight colours. The prime meridian through the pole and the circle perpendicular to it marked as straight lines.

1876. *Lent by C. E. De Rance, F.G.S.*

The topography is taken from the chart accompanying the Admiralty correspondence connected with the British arctic expedition of 1875. The geological boundaries of Parry Islands and the north coast of America from the determinations by Conybeare, Murchison, Salter, and Haughton of the specimens brought back by the expeditions of Franklin, Parry, Back, John and James Ross, Sabine, Buchan, Beechey, Sherard Osborn, and McClintock. Those of West Greenland from the observations of Giesecké, Nordenskiöld, O'Heer, and Brown. Those of East Greenland and Spitzbergen from the results of the various Austrian, Swedish, and North German expeditions. Those of Hall Basin, and the channels lying north of Smith's Sound, from the labours of Kane and Bessels, which prove that the upper Silurian rocks, noticeable along the southern fringe of the Arctic archipelago reappear in this tract, the Lower Carboniferous coal-bearing sandstones and overlying Carboniferous Limestones lying in a basin.

187. Geological sketch map of South Africa, compiled by E. J. Dunn. From observations made by Messrs. A. C. Bain, Wylie, T. Bain, junior, Dr. Atherstone, R. Pinchin, and the compiler, in Cape Colony, together with those of Dr. Sutherland in Natal, and of Mr. E. Button north of 24° latitude. Scale, about 23 miles to the inch. Size, 35 in. by 22 in. No date. Shows 14 colours.

1876. *Published by E. Stanford.*

188. Sketch of a new geological map of Victoria, by R. Brough Smyth, F.G.S. Scale, 17 miles to the inch. Size, 38 in. by 26 in. Shows nine colours for stratified and four for igneous rocks.

1876. *Lent by the Agent-General of Victoria.*

189. Relief map of Victoria, geologically coloured, by Alfred R. C. Selwyn, Government Geologist and Director of Mining and Geological Surveys, Melbourne, 1863. Scale, 8 miles to the inch. Size, 70 in. by 50 in. Lent by the Agent-General of Victoria. Shows 17 colours for the various rocks.

1876. *Lent by the Agent-General of Victoria.*

No names of mountains, rivers, or towns are given, but the various colours are marked on the map with MS. number corresponding to the index. A part is marked off by a pencil line,

the geology of which has been minutely surveyed; the remainder partakes of the nature of a sketch map.

190. First sketch of a geological map of Australia, including Tasmania, by R. Brough Smyth, F.G.S., 1873. Scale, 110 miles to the inch. Framed and glazed.

Published under the direction of the Minister of Mines, 1876. *Melbourne.*

Shows six colours for stratified rocks and four for the crystalline.

191. Geological map of Queensland, by Robert Jack, 1886. Scale, 32 miles to the inch. On rollers. Shows 16 colours.

From Museum of Practical Geology, Jermyn Street. 1887.

192. Geological sketch-maps (2) of New Zealand, by James Hector, M.D., F.R.S., Wellington, 1873. Constructed from the official surveys of the Geological Department. Scale, 33 miles to the inch. One mounted in frame. Show 12 varieties of rock, and give eight horizontal sections of the country.

1876. *Lent by J. Hector, M.D., F.R.S.*

193. Relief map of New Zealand on the same scale as the geological map, *i.e.*, 33 miles to the inch, with a vertical scale four times the horizontal. This model, which has no names, is placed beside the geological map to illustrate the forms of the surface of the parts of the country occupied by the different geological formations, but it is not itself geologically coloured. Modelled by Dr. Hector, 1876.

1876. *Lent by J. Hector, M.D., F.R.S.*

194. Geological map of Barbados, by J. B. Harrison, F.G.S., and A. J. Jukes Browne, F.G.S. Based on the survey made for the Admiralty by Staff-Commander J. Parsons, R.N., in 1869. Scale, $1\frac{1}{3}$ in. to the mile, or 3,960 feet to an inch. Size, 3 ft. 4 in. by 2 ft. 3 in.

Lent by the Geological Laboratory, Royal College of 1891. *Science.*

B.—*Geological. Local Maps, including Surveys.*

195. Geological survey of Scotland. Map of the Ayrshire coalfield and adjoining districts on the scale of

six inches to the mile. A large map on rollers, formed of 60 sheets of the 6 in. Ordnance Survey mounted together.

Lent by the Geological Survey of Scotland, Prof. A.
1876. *Geikie, F.R.S., Director.*

This map is an illustration of the detailed work of the geological survey of Scotland. The whole county of Ayrshire is surveyed on this scale, though only the mineral districts are published on these maps, the general map of the country being on the scale of 1 in. to the mile. At the foot of the map a MS. sheet is inserted to show the stages of progress in the field work of the survey. Two specimens are likewise given of the detailed vertical sections on the scale of 40 ft. to the inch, which are published in illustration of these coalfields.

196. Selection of maps and publications to illustrate the progress of the Geological Survey of Spain.

Presented by the Commission of the Geological Map
1877. *of Spain, Madrid.*

The following are exhibited:—

(*a.*) Geological map of the coalfield of San Juan de las Abadesas, province of Gerona, by Amalio Maestre, Madrid, 1855. Scale, $\frac{1}{50000}$, or more than 1 in. to the mile. Shows five different colours.

(*b.*) Geological map of the province of Palencia, by Don Casiano de Prado, Member of the Commission of the Geological Map of Spain, 1856. Scale, $\frac{1}{400000}$, or about 7 miles to the inch. Shows 10 colours.

(*c.*) Geological map of the province of Valladolid, by Don Casiano de Prado, 1854. Scale, $\frac{1}{400000}$, or about 7 miles to the inch. Shows three colours.

(*d.*) Geological map of the province of Madrid. Published by the Council of Statistics of the Kingdom of 1864, and formed by Don Casiano de Prado, Engineer of Mines, Member of the Commission of the Spanish Geological Map, 1854.

(*e.*) Graphical scale of altitudes of the northern part of the province of Palencia. Made by the direction of Don Casiano of Prado, 1856.

(*f.*) Geological and stratigraphical map of the mountains of the province of Palencia, by Don Casiano de Prado, 1857.

(*g.*) Sections of the north and north-east of the province of Madrid, including the Sierra di la Yruela and the Cerros de Concha within the limits of La Puebla de la Muger Muerta.

197. Geological and topographical atlas accompanying the Report of the Geological Exploration of the Fortieth Parallel, made by the authority of the Honourable the Secretary of War under the direction of Brigadier and Brevet-Major-General A. A. Humphreys, Chief of En-

gineers, U.S.A., by Clarence King, United States Geologist in charge, 1876.

1883. *Lent by Prof. J. Norman Lockyer, F.R.S.*

A folio atlas, 33 in. by 24 in., containing five geological and five topographical maps, and one of geological sections. Each of these maps, whether geological or topographical, representing the same areas, are in two sheets. The former are contoured at intervals of 300 ft., the latter are shaded. There is also a sketch map of the Cordilleras of the Western United States.

198. Geological and geographical atlas of Colorado and portions of the adjacent territory. Department of the Interior, United States Geological and Geographical Surveys of the Territories, by F. V. Hayden, United States Geologist in charge, 1877.

1883. *Lent by Prof. J. Norman Lockyer, F.R.S.*

A folio atlas, 27 in. by 19 in. Contains three general, six topographical, and six geological maps, two sheets of geological sections, and two panoramic views. The general maps are on the scale of 12 miles to the inch. The topographical and geological maps on a scale of four miles to the inch. They refer to the same areas respectively, each including $2\frac{1}{2}$ degrees of longitude and $1\frac{1}{4}$ degrees of latitude, and are each contoured at intervals of 200 ft., differing only in the colouring. Each is in two sheets.

199. Five outline sections of the strata under London, with a block index plan.

1876. *Lent by the late R. W. Mylne, F.R.S.*

This contains, mounted on one sheet, framed and glazed, the following :—

(*a.*) Section of a well sunk at Hampstead Road reservoir, 1838, with details of the strata and their thicknesses.

(*b.*) Plan of London and its suburbs, 1851. Scale, about two-thirds of a mile to the inch.

(*c.*) Section of the London strata in a direct line from Hampstead to Camberwell, 1850. This is deduced from the sections of wells sunk in spots adjacent to the line of section, 24 of which are indicated in position, with the strata exposed in the section. Horizontal scale, 3 inches to the mile, vertical scale, 100 feet to an inch. The whole coloured geologically.

(*d.*) A similar section from Highgate to Peckham, with 22 well sections.

(*e.*) A similar section from Newington to Lewisham, with 18 well sections.

(*f.*) A similar section from Kensington to Greenwich, with 12 well sections.

(*g.*) A similar section from Chiswick to Bow, with 24 well sections, all on the same scale and all constructed in 1850.

200. Topographical map of London and its environs, coloured geologically, by R. W. Mylne, C.E., F.R.S., 1851. Scale, 1·43 inches to the mile. 100 square miles.
1876. *Lent by the late R. W. Mylne, F.R.S.*

201. Geological map of London and its environs, by R. W. Mylne, F.R.S., 1871. 159 square miles. Scale, 1·43 in. to the mile.
1876. *Lent by the late R. W. Mylne, F.R.S.*

The same map as No. 200, but now more complete. The heights are indicated by roughly drawn broken contour lines. Below the map is a geological section from Hendon to East Wickham, on the same horizontal scale, but with a vertical scale of 500 feet to 1 inch.

202. London and its environs, topographical and geological. 131 square miles. Scale, $\frac{1}{17632}$, or 3·72 inches to the mile, with English and French geological references, by R. W. Mylne, F.R.S., 1855.
1876. *Lent by the late R. W. Mylne, F.R.S.*

This consists of nine sheets of Wyld's map of London. The levels are marked with contour lines at distances of 10 feet, and the hills are also shaded. There are two descriptive indices, one in English, the other in French. Varnished and mounted in frame.

203. Map of the geology and contours of London and its environs. Plain, and coloured geologically. 176 square miles. Scale, $\frac{1}{17632}$, or 3·72 inches to the mile. By R. W. Mylne, F.R.S., 1856.
1876. *Lent by the late R. W. Mylne, F.R.S.*

204. Geological map of the tertiary and cretaceous districts of England, and the north of France, Belgium, Holland, Denmark, the coalfield areas, and contoured depths of the adjacent seas, by Robert W. Mylne, F.R.S., 1862. Scale, $\frac{1}{500000}$, or 7·891 miles to the inch.
1876. *Lent by the late R. W. Mylne, F.R.S.*

Compiled from the maps of Messrs. Dufreynoy and Élie de Beaumont, Dumont, Bach, the British and French Ordnance and Geological Surveys, and Admiralty charts, Greenough, Godwin Austen, Prestwich, Murray, &c. The marine contour lines represent each additional depth of 10 fathoms, and at various places the depths in feet are indicated thus (167). The figures on the land represent altitudes above the sea level. The colours given

indicate the Drift, Tertiary, Chalk, Upper to Lower Greensand, Wealden, and Carboniferous. Areas containing rocks of other ages are left uncoloured.

C.—*Physical Maps.*

205. Relief map of Switzerland, by R. Leuzinger. Scale, $\frac{1}{530000}$, or about $8\frac{1}{2}$ miles to the inch; size, 28 in. by 19 in.

1884. *Published by J. Würster & Co., Zurich.*

This is not a raised map. No names are inserted on it, but there are contour lines at intervals of 100 metres, every fifth one being dotted instead of continuous. One side of all elevations is shaded darker so as to give the effect of relief. The land is brown, rivers in dark blue, lakes in light blue, snow fields and glaciers in blue of a still lighter shade.

206. Map of Switzerland, by R. Leuzinger. A folded map opened out and framed. Scale, $\frac{1}{400000}$, or $6\frac{1}{2}$ miles per inch; size, 3 ft. by 2 ft. The elevations are shaded on one side to give the effect of relief, the water and ice in blue.

1876. *Published by J. Dalp, Berne.*

207. Portfolio of maps and photographs of the neighbourhood of Zermatt, in illustration of the model of the district of the Matterhorn.

1887. *Published by J. Würster & Co., Zurich.*

The following are the contents:—

1. Photographic map of the relief model.
2. Map of the relief model on a scale of $\frac{1}{100000}$.

3–8. Topographical maps of portions of the area on a scale of $\frac{1}{50000}$.

9. View of Mischabel and Alphubel.
10–11. Matterhorn, Gabelhorn, Dent Blanche from Rothhorn.
12–13. Monte Rosa, Breithorn and Matterhorn from Dôm.
14. Dent Blanche and Rothhorn from Dôm.
15. Strahlhorn and Rimpfischhorn.
16. Monte Rosa and Lyskamm.
17. Zwillinge and Breithorn.
18. Theodul Pass and Matterhorn.
19. Mischabel and Alphubel.
20. Weisshorn.

Nos. 15 to 20 are taken from over Rothhorn.

21. Monte Rosa and Gorner Glacier.
22. The end of the Gorner Glacier.
23. Schwarz see and Gabelhorn.
24. Schwarz see and Weisshorn.

X. Photographs illustrating Geological Phenomena.

208. Photographic views prepared by the United States Geological and Geographical Survey of the Western Territories.

1877.

Given by F. V. Hayden, Geologist in charge.

These are 74 large views mounted in frames and glazed. The following are their legends :—

1–12. Unnamed.
13. Eroded sandstone, Monument Park, Colorado.
14. Needle Rocks, Garden of the Gods, Colorado.
15. Unnamed.
16. Mummy Rock, on the Sweetwater.
17. Lower Falls of the Yellowstone.
18. Unnamed.
19. Giant's Club, Greenriver.
20. Montezuma's Cathedral, Garden of the Gods, Colorado.
21. Unnamed.
22. Badlands, on Black's Fork.
23. Badlands, on Black's Fork.
24. Echo Cañon, Upper Pacific Railroad.
25. Mountain of the Holy Cross.
26. Devil's Gate, on the Sweetwater.
27. Unnamed.
28. Garden of the Gods, Colorado.
29. Green River Butte.
30. Uinta Mountains, Head of Black's Fork.
31. Laramie Peak.
32. Gilbert's Peak, Uinta Mountains.
33. The Teton Range, South.
34. Devil's Gate, Weber Cañon, Upper Pacific Railroad.
35. Beaver's Work.
36. Beaver's Dam.
37. Great-Salt-Lake City. The Tabernacle.
38. Mormon Tabernacle.
39. Quarrying granite for the Mormon Temple.
40. Great Salt Lake City, Wasatch Mountains.
41. Gardiner's River Hot Springs, Diana's Bath.
42. Hot-Spring Fissures, Gardiner's River.
43. View on the Uinta Mountains.
44. Mammoth Hot Springs, Gardiner's River.
45. Liberty Leap, Mammoth Hot Springs.
46. Crater of Architectural Geyser, Lower Fire-hole Basin.
47. Mammoth Hot Springs on Gardiner's River.
48. Upper Fire-hole, Geyser Basin.
49. Boiling Mud-Spring.

50. Mud-Geyser in action.
51. Boiling Mud Spring.
52. Grotto Geyser.
53. Distant view of the Castle Geyser.
54. Crater of Giant Geyser.
55. Crater of the Grand Geyser.
56. Crater of the Grotto Geyser.
57. Crater of Old Faithful.
58. Crater of Castle-Geyser.
59. Fishpot-Spring in Yellowstone Lake.
60. The Beehive-Crater.
61. Mammoth Hot Springs.

The following 13 are of larger size :—

62. Lake San Cristoval.
63. View near the head of Lake Fork, of Gunnison River, Colorado.
64. View on Lake Fork, looking up Snare Creek, Colorado.
65. The Upper Twin Lake, Colorado.
66. George Town, Colorado.
67. Baker's Park and Sultan Mountain.
68. Gray's Peak from Argentine Pass.
69. Grand Cañon of the Yellowstone.
70. Falls on the San Miguel, Colorado.
71. Mammoth Hot Springs, Gardiner's River.
72. Gateway of the Garden of the Gods, Colorado, Pike's Peak.
73. The Colorado, or Front Range from near Gold Hill.
74. Great Falls of the Yellowstone.

209. Photograph of the great crater of Vesuvius, showing the interior after the eruption of 1872. Size of photograph, 18 in. by 5 in.

1876. *Lent by the late Robert James Mann, M.D.*

This photograph was taken by Mr. J. M. Black, from the gap in the broken edge of the rim. The top of the great rent, extending north and south through one side of the cone to the Atro del Cavallo, is shown on the further side of the crater between the rounded and pointed eminences.

XI. Miscellaneous.

210. Models (4) to illustrate the effects of great movement on the earth's crust. Made by Dr. Ricketts. *See* "Geological Magazine," April 1889.

E. 28 to 31.—1889. *Presented by Dr. Ricketts, F.G.S.*

The position of the consolidated clay is marked by the letter C, while B shows layers of clay originally in horizontal beds, but

squeezed into folds by the vertical pressure of S, sand, extra weight being applied.

211. Specimens illustrating the production by compression of natural and artificial slaty cleavage.
1876. *Lent by Dr. H. C. Sorby, F.R.S.*

These specimens are of historical interest, as illustrating the Presidential Address to the Geological Society by Dr. Sorby in 1880. *See* Q.J.G.S., Vol. XXXVI. Dr. Sorby's description of these specimens is :—

"Specimens of slaty rocks, showing by various facts that they have been greatly compressed in a line perpendicular to the cleavage.

"Pipe-clay with portions of blue paper, and also with iron scales, being the results of the first experiments made to show that a structure like that which causes the cleavage in slates can be artificially produced by pressure.

"Artificial cleavage in compressed flaky graphite, being as perfect as in any slaty rock."

These specimens consist of a mass of sandstone in which there is a spherical green patch ; two blocks of purple Penrhyn slate in which a similar green patch is compressed into a spheroid, and a third block in which there is an irregular green band. There is also a piece of fossiliferous Devonian slate in which fossil Brachiopods, which were originally symmetrical, have been drawn out and elongated in the plane of cleavage.

There are four specimens of pipe-clay with specks of blue paper, one of which is labelled, "First experiment to see the "change in position of particles in clay, whose dimensions were 'changed by pressure. End of 1850 and beginning of 1851." Another is "A cube of pipe clay and iron scales mixed evenly." The others are flatter and broader pieces, probably representing the same volume with the scales in the pipe-clay parallel to the broad surface. There is also a pill box with flaky graphite.

212. Specimens illustrating the metamorphic origin of mica schist, and the difference between stratification foliation, and cleavage foliation.
1876. *Lent by Dr. H. C. Sorby, F.R.S.*

These are further illustrations of another portion of Dr. Sorby's address. His description of these specimens is :—

"Ripple Drift in slate rocks in which the cleavage cuts the stratification at a considerable angle."

"Ripple Drift in contorted and highly metamorphosed mica schist, thus proving the original stratified nature of the rock."

"Mica schist with foliation in the plane of cleavage, developed by compression before the rock was metamorphosed."

These specimens comprise :—A large green slate from the Lake District showing ripple drift ; two slabs of the coarse agglomeratic green slate of the Lake District, so cut as to show the irregular shape and arrangement of the fragments as seen on the cleavage surface, contrasted with their uniform elongation in the same direction as seen in the plane perpendicular to the cleavage; a piece of contorted foliated quartzite, labelled "Inverary, with foliation in the axis of compressed contortions ;" two specimens of compressed mica schist with the layers pulled out in their own direction; and an unlabelled piece of dark mica schist, which has been much contorted and broken along lines in which mica is developed, and between these there are other curving transverse lines also filled with mica.

213. Lithographed plates, illustrating the microscopic structure of limestones.

1876. *Lent by Dr. H. C. Sorby, F.R.S.*

These show structures due to larger or smaller fragments of organic bodies or grains of sand, and to the more or less complete development of crystals formed either during or after the deposition of rock.

214. Collection of specimens of calcareous and siliceous deposits from the geysers of the Yellowstone valley.

Presented by Prof. Hayden through the United States
E. 4.—1881. *Engineer Bureau of the War Department.*

There are a large number of specimens of various sizes, some broken off from solid masses, and some in a rolled condition. They are all white and sintery in aspect, and there is no indication as to which are calcareous and which are siliceous.

215. Specimens of minerals from Australia.

Given by J. R. Fairfax, "Sydney Morning Herald"
E. 1.—1874. *Office.*

Two mahogany trays with 68 fixed compartments, each 2 in. square.

216. Minerals from New Brunswick.

Given by R. Britain, St. John's, New Brunswick.
E. 170 to 174.—1868.

See Report on the Geology of New Brunswick by H. Youle Hind.

1. Copper ore from Charlotte county.
2–4. Albertite from Albert county.
5. Iron ore from Woodstock, Carleton county.
6. Iron ore from Westbeach, St. John's county.
7. Bituminous shale or schist from Baltimore, Albert county.

217. Collection of minerals and Silurian fossils from Bohemia.

E. 8.—1862. *Presented by M. Wenzel Fric, Prague.*

A small box with two trays, each divided in 30 compartments, measuring 1½ in. by 1 in., and containing small specimens.

218. Collection of fossils from the environs of Grignon in Savoy, classified upon Delamarck's system by M. Lambotin, Paris. From the Exhibition of 1851.

E. 10.—1879.

Consists of two cardboard boxes with printed labels in the lids, and lined with blue paper, each with 30 compartments, with one or two fossils mounted in each. The first box contains mostly Gasteropods, the second mostly Lamellibranchs. The names are of the period of 1822.

219. Specimen of galena from the Roman gravel mines, Minsterley, Shropshire.

220. Specimen of plumbago from the mine at Trieben in Styria. Analysis 90·8 carbon, 9·2 ashes of fireproof pyrites.

1871. *Exhibited by G. Bekits.*

221. Samples (6) of graphite in the rough.

E. 32.—1862. *Presented by the Russian Government.*

222. Specimens (3) of opal rock from the mines of Dubrich, near Eperies, Upper Hungary. Two large and one smaller irregular mass.

E. 9.—1870. *Presented by Mrs. Leverson.*

223. Specimens (2) of "onyx marble," a variety of carbonate of lime. Reported to have been found in the lava of 1852 on Mount Etna.

E. 10.—1878. *Presented by Mrs. Frederic Watt.*

224. Model of a large gold nugget found in Sampson's creek, California.

E. 8.—1859. *Presented by W. T. Deverell.*

225. Model of a meteoric stone which fell at Dundrum, co. Tipperary, Ireland, on the 12th of August 1865.

E. 187.—1868. *Given by Viscount Hawarden.*

The original is now in the Geological Museum of Trinity College, Dublin.

226. Fossil tooth of a Mammoth.
E. 46.—1872. *Given by J. Duff Gordon.*

227. Nodule containing ammonites capricornus from the lias of Whitby.
E. 13.—1869. *Presented by J. Finnie.*

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